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Natural History of the Bistcho Lake Region, Northwest Alberta

Edited by
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Provincial Museum of Alberta

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FOREWORD

Science and museums have had a long historical relationship; a marriage of several hundred years that has spawned much of our knowledge of antiquity and the natural world. There are several identifying characteristics of the science practiced by museums: it typically centers on and revolves around the acquisition of specimens or artifacts and their amalgamation into a superorganism, the collection. It has a mystique grounded in the act of acquisition often in remote, little known areas. Much of its purpose is discovering, identifying, naming and organizing each object. The communication of the knowledge gleaned from the acquisitions rests heavily upon the visual presentation of the specimens which are preserved, stored and reused in the future to reaffirm our knowledge, to communicate it to new audiences or to contrast it with new, contrary, or greater evidence.

Contrary to an often expressed opinion that there is little new territory for museum science to undertake, museums have only begun to scratch the surface of the areas of knowledge which are their forte. It is sad but true that many museums are guilty, either by commission or omission, of propagating this erroneous opinion, by the way they practice their science. All to often the drive to seek out, explore, discover and acquire objects is wanting on the part of those who purport to do museum science. They are, instead, seemingly content to maintain the collections already contained within their museum. Museums in that mold can be likened to a camatose patient who, although alive, displays a fraction of the vitality and energy of a healthy individual.

Alberta represents a vast untapped field for the practice of original museum science. One of the later parts of Canada to be settled, it has a phenomenal natural diversity that often mitigated against early access. Further, until recently, it had a rural aspect to its collective consciousness, which along with a dearth of early exploration, resulted in a minimal, patchwork approach to the practice of museum science. We are far from having a broad-based knowledge about our region, its history, its people, and its natural environment.

In 1987 the Natural History Curatorial Programs at the Provincial Museum of Alberta undertook to do something about the lack of systematically gathered, museum based, knowledge of Alberta. We instituted a series of multidisciplinary expeditions to remote or previously unexplored areas of the province. The objectives of the expeditions were simple yet eloquent in nature: discover what was there, acquire a permanent record, and tell people about it. Our motivation was historically derived, i.e., if you cannot go to a museum to find out what is out there, where can you go?

Bistcho Lake, in the remote northwestern corner of the province, was selected as the site for the first expedition. It is accessible only by air, or until recently, along winter trails, and the minimal amount of biological investigation in the area has been oriented almost exclusively towards the commercial or economic aspects of the natural environment.

However, Bistcho Lake was chosen not just for these reasons. There were likely to be many species of plants and animals that would be new for the province, as the region represents a confluence of both subarctic and Pacific floral and faunal elements. Discontinuous permafrost occurs in the region, increasing the possibility of communities encountered which would reflect in part some of the structural elements expected in older (i.e. Pleistocene) times. Ranges of organisms could be expected to be extended, distributional gaps to be filled and taxonomic detail added. Equally significant, the resulting collections would become the essential, but until now unvailable, material required for secondary and tertiary levels of science and understanding about the natural history of the region.

The programs selected for participation included botany, invertebrate zoology, ornithology and mammalogy. In addition some effort was applied to the reptiles, amphibians and fish of the region, although on a less systematic basis. In total there were 12 people on the expedition, a crew which could more than hold its own against any other that I have known.

The expedition left Edmonton in 3 vans carrying all our equipment, supplies and gear on 12 June and drove to High Level. There Peace Air was chartered to Bistcho Lake and Jack Halverson's Tapawingo Lodge, which was our home for the next 10 days. Collecting parties moved out from the lodge on a

daily basis, setting and checking nets and traps, collecting specimens and information, and recording the data required to establish scientific context.

Over the days our supplies dwindled while the inventory of specimens and data grew; more and more of the area revealed itself in response to our efforts. Rarer species not initially encountered were recorded and documented; the phenology of the season produced greater detail about what we had first observed. Through time our presence brought us into contact with residents who could in many cases put our observations into a longer perspective than our brief stay afforded. By the end of the expedition we had collected a total of 231 botanical specimens, an estimated 5000 invertebrate specimens, 8 herpetological specimens, 99 ichthyological specimens, 162 mammalogy specimens, and 245 ornithological specimens. Here, for the very first time, was a broad-based collection from northwestern Alberta, an accomplishment whose act of undertaking gave each of us a kinship not only among ourselves but also with earlier museum workers who had pushed into other new areas, discovered their mysteries and brought them home. Fieldwork, the primary act of collecting, is one of the greatest thrills of museum work.

But our work had only begun. What is collected in the short space of a few days, takes many more to prepare, identify and incorporate into a museum's knowledge base. The following pages contain the discipline by discipline results to date of our expedition to Bistcho Lake. They indicate what was collected and, where possible, what the new specimens mean to our understanding of the area and its relationship to other regions of Alberta.

Much remains to be done, however, particularly with the extensive invertebrate collections; the basic work of identifying and classifying the specimens will involve specialists, in a number of institutions, over many years to come. What has changed significantly and irrevocably is, that for the first time, there are collections available from the area that will enable museum and other scientists to freshen and add to our collective knowledge. What we have done pales in comparison to the museum expeditions of the 1800s, the golden age of discovery, but it pales only by degree not in kind.

I am proud to have taken part in the Bistcho Lake expedition; initiating this type of undertaking at the Provincial Museum of Alberta has been a driving force for me since I began working there. Our 1988 expedition will take us to Andrew Lake, in the poorly known Canadian Shield region of northeastern Alberta. In subsequent years we will continue to undertake other expeditions into remote areas, replacing the patchwork pattern of general biological investigation with a more systematic approach, one that leaves a permanent record of the discoveries and one that encourages their use.

Dr. Philip H.R. Stepney,
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Bob Ellis	Jim O'Hara
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The editors

ENVIRONMENT, VEGETATION, AND FLORA OF THE BISTCHO LAKE AREA, NORTHWEST ALBERTA

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Bistcho Lake lies in the far northwest corner of the province of Alberta, about 20 km from the Northwest Territories border. It is in a remote area, surrounded by treed wetlands. There are no roads and access is limited to small planes or long overland hauls with all-terrain-vehicles. Consequently the area is under-explored botanically; it was not included in the classic expeditions of Moss (1953a, b) and Raup (1935, 1936, 1946). Fairbarns (1983) published a biophysical survey on the Cameron Hills, which lie about 40 km to the east of Bistcho Lake. His appears to be the only previous botanical report done for the region.

Soils and surficial geology of northwest Alberta were surveyed by helicopter in the late 1950's by Lindsay et al. (1958, 1959, 1960). These surveys included 10 soil pits investigated in the vicinity of Bistcho Lake. The surficial geology was interpreted from these pits and from the over-flights.

The primary purposes of this botanical investigation were to describe the vegetation, collect the vascular and non-vascular flora, and to develop a checklist of these taxa. Secondarily, we examined the soils and surficial geology and provided general habitat descriptions for use by zoologists.

METHODS

Three sets of air-photos (1979 1:15000 infra-red, 1979 1:50000 infra-red and 1983 1:60000 panchromatic black and white) and the forest cover type maps (1980 1:50000) were obtained for the study area. We used these to identify habitat types that were to be investigated in the botanical survey. The 1:15000 photos, although providing the greatest resolution, were of limited value as they covered only the very southern and southeastern parts of the lake and thus were largely out of the study area. Due to their low resolution the 1:60000 photos were also of limited value in identifying vegetation features. The forest cover maps coincided with the air-photos only in a very general way and their classification of forest types was too general for the purposes of this survey. Therefore, all vegetation identification was done from the 1:50000 air photos as these had sufficient resolution for accurate identification of vegetation types and there was complete coverage for the area. These photos were also used to make the final landscape and vegetation maps which appear in this report.

As a primary purpose of this investigation was to establish a floristic list for the Bistcho Lake region, we used seismic lines that criss-cross the area to cover as much territory as possible. Due to time constraints, limited emphasis was placed on detailed community and soils descriptions. Based on air-photo and ground reconnaissance, we chose 6 representative stands for detailed description. Sites were considered suitable for sampling if they were relatively homogeneous over a 0.5 hectare area and were free of human disturbance. A 10 x 10 m plot at each site was used to estimate the percent cover of tree species. Percent cover of all remaining species (i.e., shrubs, herbs, bryophytes, and lichens) was estimated in a 5 x 5 m plot. About 6 trees were cored at 20-30 cm height to obtain a stand origin date and to assess the distribution of tree age-classes. We described the surficial geology and made notes on site characteristics, including: slope, aspect, elevation, moisture, and drainage. Moisture was assessed using a 5 point scale: Xeric (X), Xeric-Mesic (XM), Mesic (M), Mesic-Hydric (MH) and Hydric (H). We measured drainage on a 3 point scale: Well (W), Moderate (M), and Poor (P).

In addition to the seismic lines, which crossed a large number of habitats, special landscape features seen on the air-photos (e.g., beach ridges) were also chosen for study. We made notes on habitats seen along the seismic lines and dug small pits to check the surficial geology. When plants were collected, their habitats were described in terms of associated dominant species, landform type, and surficial geology. For sites close to base camp, we took plant presses into the field so specimens could be pressed fresh. However, on walks to distant sites plants were collected in plastic bags and pressed each evening. Non-vascular plants were collected in paper bags

and were not processed until returning to the Provincial Museum. We identified all plants, vascular and non-vascular, in the field and compared these to the list compiled by Fairbarns (1983) for the Cameron Hills. In this fashion we continually tracked our collecting progress to avoid excessive duplication of collection material and could focus our search on finding specific habitats and species.

Generally, the terrain is boggy and the seismic lines are often overgrown with tall shrubs. As cross-country travel was tiring, we found that collecting success increased if one person navigated through the bush, searching for specific stands, while the second person concentrated on the search for plant species. Once a new species was spotted, we would search the immediate area for additional new species.

Upon return to the Provincial Museum all vascular species were identified. Species nomenclature follows Moss and Packer (1983). Non-vascular species identifications were confirmed by Dr. D. H. Vitt of the Department of Botany, University of Alberta. Moss identifications follow Ireland (1982) while lichens conform to Egan (1987). All specimens have been deposited at the P.M.A. herbarium (PMAE).

In order to determine the geographic significance of the flora, comparisons were made with distributions described in the literature. The distributions of vascular plants were determined from the descriptions and maps of Hultén (1968), Porsild and Cody (1980) and Moss and Packer (1983). The biogeographic zones used were those described by Raup (1947). The distributions of lichens were taken from the descriptions and maps of Thomson (1984) and Bird and Marsh (1972, 1973). Bryophyte distributions were taken from the general descriptions provided in Schofield (1969). Details of the biogeographic analysis are described in the floristic section below.

ENVIRONMENT OF THE BISTCHO LAKE AREA

Physiography

The Bistcho Lake area is part of the Cameron Hills Upland, a region of Cretaceous strata that covers the northwestern corner of Alberta, northeastern British Columbia, and the adjacent parts of the Northwest Territories. This upland is part of the Alberta Plateau, which also includes the Buffalo Head Hills near High Level, the Caribou Mountains of north-central Alberta, and the Horn Plateau west of Great Slave Lake. These extensive plateaus are separated from one another by the lowlands of the Great Slave Plains in the Northwest Territories and northeastern Alberta, and the Fort Nelson Lowland of northwestern Alberta (Clayton et al. 1977). The uplands of the Alberta Plateau are believed to be erosional remnants left after Tertiary rivers carved out the intervening lowlands. The north side of the Cameron Hills Upland forms a broken escarpment while its southern boundary grades into the Fort Nelson Lowland (Clayton et al. 1977).

Glacial History

Glaciers of the Pleistocene Epoch did not significantly alter the preglacial landscape of northwestern Alberta, but they determined the nature of the region's parent materials and microtopography (Clayton et al. 1977). In turn, these two landscape features can be expected to affect vegetation patterns in the study area.

The Bistcho Lake area was covered by Laurentide glacial ice during the Wisconsin. The Caribou Mountains deflected the prevailing southwesterly flow of the ice-sheet so that in the Bistcho Lake area the ice apparently advanced from the northwest (Bayrock 1960). This trend is indicated by the occurrence of large glacial flutings which have a northwest-southeast orientation (Fairbarns 1983). The ice-sheet appears to have affected the local landscape primarily by deposition and incorporation of its load with underlying Cretaceous sediments (Clayton et al. 1977). During the waning phases of the Wisconsin glaciation, large masses of ice became stagnant in northern Alberta; deglaciation was accomplished by a general lowering of the glacial surface rather than by frontal retreat. The occurrence of hummocky moraine, which covers much of the Cameron Hills, is cited as evidence of this stagnation (Bayrock 1960, Clayton et al. 1977).

Low-lying ridges are quite evident on the eastern side of the Bistcho Lake area. On black-and-white infrared air-photos they show up as a series of lightly colored ridges with a very coarse north-south grain. The light color is due to the presence of *Populus tremuloides* which dominates the ridge tops. Ground surveys revealed that these ridges are composed of clays, and/or silty-clays, which incorporate a large amount of rounded clasts. The relative relief of these

ridges, their clayey or silty-clay texture and the presence of rounded stones suggest that these ridges are probably hummocky moraine, deposited during the ice stagnation phase of deglaciation. The silty and stoney parent material and relatively high topographic position contribute to better drainage on the ridges than in the surrounding lower areas. This improved drainage contributes to the establishment and maintenance of the *Populus tremuloides*[1] stands.

There are many small, rounded lakes in the Bistcho area. These lakes may be kettles that formed during ice-stagnation/deglaciation. The kettles resulted from the melting of ice blocks that were either buried by till from the hummocky moraine, or became isolated and surrounded by meltwater sediments. The melting of the ice blocks created depressions in which lakes have formed. From air-photos it appears that both types of kettles may be in the area. Lakes are well-developed in hummocky moraine and also many small ponds occur in over-widened channels which appear to be glacial meltwater channels. Ground-truthing is necessary to evaluate these possibilities.

Continued ice-sheet melting resulted in the release of large quantities of water, producing many proglacial lakes (Bayrock 1960). Associated with these lakes are areas of coarse-textured sediments which have been attributed to glacial-fluvial action near the ice-sheet margin (Clayton et al. 1977).

It is reasonable to assume that Bistcho Lake filled during this period of deglaciation and is the remnant of a proglacial lake. At the southeast corner of the lake, in an area of very low relief, there are extensive sandy deposits (Fig. 1). These deposits support *P. tremuloides* and *Pinus* communities not found elsewhere along the east shore of Bistcho Lake. This sandy area is bounded to the north and south by 2 misfit stream channels. These channels meander across the lowland and in places dissect ridges of hummocky moraine. They are very wide compared to the present stream course and have a boxshaped cross-section. Soil profiles in the sandy deposits reveal an upward fining sequence from coarse to fine sands. Along the lakeshore linear north-south ridges are readily apparent on air-photos and appear to be old beach ridges. Inland, in the pine stands, these north-south trending ridges are not evident; the ridges are much smaller and lack a consistent trend. These sandy deposits, which support plant communities not found in the surrounding till and organic parent material sites, add to the diversity of the region.

It is important to consider why sands occur in this limited area and the nature of their depositional environment. Two hypotheses can be suggested: Firstly, they may be derived from beach sands which have subsequently been reworked by aeolian action to form sand dunes. Prevailing winds are from the northwest, which result in beach sands from the lake shore being blown inland to form dunes. This hypothesis explains the inland ridges of sand and partially accounts for the geomorphology of the area. However, it fails to explain the observed upward fining sequence of the deposits, the misfit nature of the stream channels, the dissection of the hummocky moraine and, ultimately, the original source of the sand.

The second hypothesis is that deposits are from glacial meltwater channels which may have subsequently been reworked by aeolian action. A fining upwards sequence in a sedimentary profile is often indicative of fluvial depositional environments, especially glacial-fluvial, as opposed to aeolian (R.B. Rains, pers. comm.). As stream discharge drops, either from increasing distance from the glacial source or as meltwater volumes are reduced, particle size decreases, resulting in a decreased particle size upwards through the profile. The streams that bound the area are strikingly misfit. This is indicative of a high discharge carving the initial channel and, subsequently, the stream volume has decreased resulting in a misfit stream (Morisawa 1968). This would be expected where a melting glacier produces large quantities of meltwater which carve the initial channels and deposit coarse-grained sediments. With subsequent complete melt-out of the glacier, stream volume is much reduced and adjusts to the current low discharge, producing a misfit stream. High meltwater discharges could either dissect existing hummocky moraine, or the meltwater channel and the moraine could have formed simultaneously, with the moraine being deposited englacially on either side of the flowing stream. This hypothesis postulates that the sands are from deposits of proglacial meltwater channels with the glacier as the source. Subdued ridge deposits inland from the shoreline are likely sand dunes derived either from reworked proglacial deposits or from beach deposits.

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1. Scientific names are used throughout this report; Appendix 1 provides a list of common names for vascular plants.

Map No	Surficial Geology	Dominant Landform	Soil Type
1	Clay-Silt	Hummocky Moraine	Gray Luvisol
2	Clay-Sand	Hummocky Moraine - Outwash Plain	Eluviated Brunisol
3	Sand	Outwash Plain	Eluviated Brunisol
4	Sand	Beach or Delta	Orthic Gleysol
5	Organic	no dominant form	Organic Cryosol

Surveyed Stands = △

1:65,000

Figure 1. Surficial geology, landforms and soils of the Bistcho Lake study area.

More research is needed to support the glacial meltwater hypothesis suggested here. It is a preliminary hypothesis based almost entirely on air-photo interpretation. It suffers from a lack of extensive ground-truthing of sedimentary deposits.

Organic terrain comprises the largest portion of the Bistcho area and is occupied by various *Picea mariana* community types. Lindsay et al. (1960) estimate that organic terrain covers about 80% of the region. The underlying parent material is unknown as it was not possible to dig through the thick peat deposits. These deposits probably developed on low-lying areas of hummocky ground moraine but in the southeast corner of the study area they appear to have covered meltwater deposits.

Climate

The climate of the Bistcho Lake area is virtually unknown. There are no weather stations in the area and fire towers are not close to the lake. Further, the nearest towers report weather information only during the summer season. By extrapolating from surrounding weather stations, Strong and Leggat (1981) suggested that the region has a Boreal Subarctic climate. The high elevation of the Bistcho area will produce greater precipitation and lower summer temperatures than those that occur at lowland stations. Strong and Leggat predicted that mean annual precipitation is between 400 and 450 mm, with summer precipitation about 300 mm. The May to September mean temperature would be about 10^{o} C, which is considerably lower than that of surrounding boreal regions. However, winter temperatures may be somewhat higher than in surrounding low-lying areas. This is due to temperature inversions that are characteristic of high-pressure Arctic air masses that blanket the area during the winter. Under these conditions, temperatures rise with altitude so that higher elevation sites are warmer than lowland sites. However, the higher elevations will produce a shorter snow-free season and a frost-free period that is likely less than 60 days.

Soils

Because of the extensive organic deposits and the short frost-free period, soils of the area are dominantly Organic Cryosols (Lindsay et al. 1960, Clayton et al. 1977, Strong and Leggat 1981). Mineral soils are better drained and somewhat warmer but soil profile development is weak. Luvisols and Brunisols have developed on better drained mineral soils and in these sites permafrost is either deeper than 50 cm or lacking (Lindsay et al. 1960, Strong and Leggat 1981).

Soil pits were dug in each of the 6 stands in which plant communities were described. The major soil horizons were identified and described in terms of depth, color, condition of the lower boundary, moisture, texture and structure. All analyses were done in the field; no soil samples were collected. Therefore, identifications of the critical B horizons are based on Munsell color descriptions and field observations of illuviation and ped development. Without chemical tests it was sometimes difficult to separate Bm from weakly developed Bt horizons, especially in the border area between clayey till and sandy outwash deposits. Also, pH measurements were not taken so it is not possible to separate some soil Great Groups of the Brunisolic order. Soils were classified using the keys of Strong and Limbird (1981) and were then checked against descriptions in the Canadian System of Soil Classification (Anonymous 1978).

Soils from 4 orders were identified in the area. These orders are Cryosolic, Gleysolic, Brunisolic and Luvisolic. Soils found in each of the stands are described below.

In the open *Picea mariana/Ledum* spp./ *Cladina-Sphagnum* community (Stand 1) which has developed on bog, a frozen layer was reached at 52 cm. The solum, down to the frozen layer, consists of undecomposed organic material from *Sphagnum* mosses (Fig. 2). Given these characteristics, this soil can be classified as a Fibric Organic Cryosol. Since this soil type is associated with the *P. mariana* heath communities that cover most of the area, it is likely that Organic Cryosol is the most common soil Great Group in the Bistcho Lake area. More extensive soil surveys are necessary to determine the relative importance of the Fibric subgroup.

Hummocks at this site are about 22 cm high and free water was reached at a depth of 34 cm from the hummock tops. A horizon of burned mosses and vascular material occurs at 22 cm, a depth equivalent to the height of the hummocks. Burned material is also evident at the surface in inter-hummock depressions. It appears that an intense fire had swept through the stand, burning the peat down to a level surface.

Figure 2. Cut-away of a *Sphagnum* spp. hummock from an open *Picea mariana* woodland. The deep, poorly decomposed, surface organic horizon is frozen at 52 cm, indicating that the soil is a Fibric Organic Cryosol.

In the shrubby *Betula pumila/Ledum* spp./*Vaccinium vitis-idaea/Sphagnum* community (Stand 3), which has developed on a sandy beach ridge near the lake shore, the soil has L-F-H and Ah surface organic layers overlying a gray, sandy mineral horizon (Fig. 3). The mineral horizon has very thin (< 5 mm) organic layers within it. These horizons indicate that the area has been disturbed and revegetated several times. In total, the surface organic horizons are 19 cm thick so this soil is not an Organic. The low chroma of the sandy mineral horizon and the wet condition of the soil, coupled with its low topographic position, suggest that it is a Gleysol. The B horizon is more than 5 cm thick but shows neither illuviation indicative of a Bt nor mottling indicative of a Bgf; this soil appears to be an Orthic Gleysol.

However, while the Ah horizon is only 7 cm thick, it has a gradational boundary with the overlying, 12 cm thick, L-F-H horizon. Because of the indeterminate nature of the boundary between the 2 organic horizons, this soil may have a thicker Ah than described suggesting an Orthic Humic Gleysol rather than an Orthic Gleysol. However, humic gleysols, while occurring in the subarctic, are often associated with more Chernozemic soils (Clayton et al. 1977). The lack of extensive sedge and grass cover supports the original classification of Orthic Gleysol.

Orthic Gleysols probably have a limited distribution on the eastern side of Bistcho Lake. Most upland low-lying areas are occupied by *Picea mariana/Sphagnum* spp. forests with thick organic deposits. Soils on the till deposits, and in sandy areas away from the shoreline, are better drained and support the development of Luvisols and Brunisols. Orthic Gleysols will be best developed along the low-lying southeast corner of the lake near the shoreline and in recent deltaic deposits.

Soils in the *Populus tremuloides/Picea mariana/Shepherdia canadensis/Vaccinium vitis-idaea* community (Stand 4) have developed on clayey-stoney till. The B horizon is more than 5 cm thick and shows marked illuviation with well-developed, platy, clay covered peds (Fig. 4). The Ae horizon is 8 cm thick and shows color values 2 units greater than the underlying B horizon. It has a 1 cm thick L-F-H horizon. These characteristics support the classification of this soil into the Gray Luvisol Great Group.

Figure 3. Orthic Gleysol developed under an open *Betula pumila* scrubland community. The top 19 cm black, organic horizon overlies sandy parent material derived from a beach ridge deposit. The grayish color of the sand is indicative of gleying.

Figure 4. A Gray Luvisol developed under a *Populus tremuloides* dominated community. The thin leaf litter (0 to 1 cm) overlies thick Ah (1 to 6 cm) and Ae (6 to 14 cm) horizons. A grayish Bt horizon forms the bottom of this profile.

Identification to subgroup is precluded by the lack of soil chemistry information on the B horizon. On the basis of illuviation and ped development the horizon appears to be a Bt, which suggests that this soil is an Orthic Gray Luvisol. Support for this identification comes from the Ae horizon which has a chroma of only 2. However, based on color, the B horizon appears to be a Bf. Its upper boundary has a 10YR hue and in more moist parts of the horizon the chroma increases from 3 to 4. This would make the soil a Podzolic Gray Luvisol. The higher elevation of the Bistcho Lake area, compared to the surrounding lowlands, may result in a significantly higher precipitation regime that would allow for the development of a podzolic type soil. Gray Luvisols are likely to be found throughout the area and should be a common soil Great Group as they will develop under *Populus tremuloides* stands that occupy the prevalent clay-till hummocky moraine.

The *Pinus/Vaccinium vitis-idaea-Arctostaphylos uva-ursi/Cladina mitis* community (Stand 2) has developed on sandy, rapidly drained parent material. The B horizon has neither clays nor ped development to indicate illuviation even though it has developed under a thick Ae horizon (Fig. 5). It has a reddish hue (5YR) and a high chroma (6). These characteristics suggest a Bm horizon and that the soil belongs to the Brunisolic order. The thick (6.5 cm) Ae horizon indicates that the soil is an Eluviated Brunisol but whether it belongs to the Eutric or Dystric Great Group is not possible to determine without a pH measurement. The well-developed Ae horizon indicates eluviation is occurring at this site but the coarse nature of the parent material inhibits the accumulation of clays and weathered products in the B horizon. This situation slows the development to a Bt horizon characteristic of Luvisolic soils.

Eluviated Brunisols are probably common in sandy sites of the Bistcho Lake area but, as this parent material is relatively uncommon, the overall extent of these soils will be small. The sandy outwash plain in the southeast corner of the study area may be the only location where these soils occur. Other stands in this sandy area show development of Eluviated Brunisols. An open *Populus tremuloides/ Vaccinium vitis-idaea/Elymus innovatus* community (Stand 5), about 1 km to the southwest of the *Pinus/Vaccinium* stand, has developed on the same outwash plain. It too has a Brunisolic soil. However, this stand has at least 2 charcoal layers in the solum and shows evidence of buried Ah and Ae horizons. The buried soil has characteristics of an Eluviated Brunisol but the surface soil lacks an Ae horizon. This site may have burned too recently for development of an Ae horizon but the buried soil indicates the potential for the stand to develop an Eluviated Brunisol.

A second stand has developed on the edge of the sandy outwash plain where sand overlies clayey ground moraine. Stand 6 is a *Picea glauca/Rosa acicularis/Cornus canadensis-Linnaea borealis/ Hylocomium splendens* community. As this stand is on the border of 2 contrasting parent materials it is not surprising that its solum has features characteristic of both Luvisols and Brunisols. The B horizon shows some ped development, indicative of a Bt, but it is very weak. The horizon has some clay but it is largely a sandy matrix. The horizon has a bright red hue (2.5YR) indicative of a Bm horizon, however, its chroma is only 2 which is low for most Brunisolic Bm's. The Ae(?) horizon is not well developed as its color value is lower than that of the underlying B horizon. This is not indicative of a Luvisolic soil. Therefore, it is best to classify the A and B horizons as Aej and Btj respectively, indicating that they are poorly developed forms of these horizons. This suggests a classification of Eluviated Eutric Brunisol according to the Canadian System of Soil Classification.

The sandy texture of the B horizon may inhibit clay illuviation in the horizon and consequently retard ped development. Further, the acidic nature of the conifer litter may retard breakdown of surface organic material which would lead to a darkening of the A horizon as humic acids accumulate. The thick, poorly decomposed, surface organic horizon indicates that leaching and breakdown of organic matter is being inhibited at this site.

VEGETATION AND PLANT COMMUNITY DESCRIPTIONS

In the Bistcho Lake study area *Picea mariana* communities dominate upland and lowland areas. These communities vary from open *Picea mariana* bogs, on organic soils, to closed *Picea mariana* forests on till deposits. On upland sites *Picea mariana* is often either sub-dominant or co-dominant with *Populus tremuloides*. Given sufficient time and a disturbance-free environment these sites will eventually be dominated by *Picea mariana*.

Populus tremuloides - Picea glauca or *Picea glauca* communities, located on better drained sites, are relatively infrequent in the study area. These com-

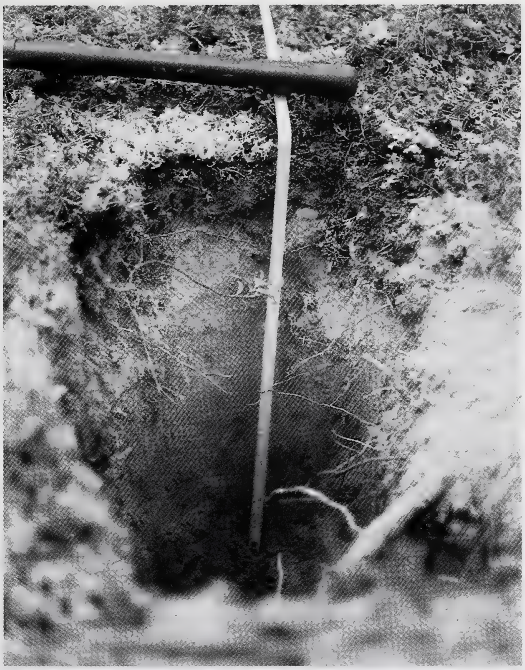

Figure 5. A typical Eluviated Brunisol in an open *Pinus banksiana/Cladonia* spp. stand. The well-developed L-F-H layer (0 to 3 cm) beneath the lichen carpet overlies a 3 cm thick Ah horizon. A very marked gray Ae horizon extends from 6 to 12.5 cm. An orange Bm horizon to about 50 cm forms the base of the profile

munities appear to be restricted to a narrow band paralleling the north shore of Bistcho Lake, on sites that have either moderate to steep south- to southwest-facing slopes or soil deposits of mixed sand and clay. Most upland sites dominated by *Populus tremuloides* have *Picea mariana*, not *Picea glauca*, as the prominent understory tree species. Fire and the well-developed moss carpet mitigate against establishment of *Picea glauca* stands. For *Picea glauca* to become established after fire there must be an available seed source, usually from outside the burned area, and exposed mineral soil (Lutz 1956). It is postulated that these 2 conditions are rarely satisfied in the Bistcho Lake area and thus the distribution of *Picea glauca* is restricted to a few sites.

Pinus banksiana or *Pinus banksiana-Populus tremuloides* communities are found only in the southeastern corner of the study area, on sandy parent materials derived from glacial outwash and old beach ridge deposits. Occasional occurrences of *Picea mariana* or *P. glauca* in the understory suggest a possible successional sequence. However, the rapidly-drained, sandy soils have a low water-holding capacity and are unfavorable to *Picea mariana* and *P. glauca* establishment. The frequency of fires in the area also mitigates against *Picea* spp. and favors the fire-adapted *Pinus banksiana.*

Shoreline communities are dominated by a narrow 2 - 3 m band of *Alnus tenuifolia* and/or *Salix* spp. The extensive shallow waters along the Bistcho Lake shoreline support a well-developed emergent and submergent vegetation. *Carex* spp., particularly *Carex rostrata*, are dominant closest to shore, with *Juncus* spp. dominant in deeper waters where *Potamageton* spp. and *Nuphar variegatum* are also prominent.

Plant Community Descriptions

Figure 6 shows the locations of the plant communities in the Bistcho Lake study area. Table 1 shows the environmental and species percent cover data collected from each of the described stands.

Picea mariana/Ledum groenlandicum- Ledum palustre/Cladina mitis- Sphagnum spp. community

Stand 1 is an open *Picea mariana* woodland community located on a poorly drained Organic Cryosol with permafrost at 52 cm (Fig. 7). *Picea mariana* is dominant in a sparse, open tree layer. *Ledum groenlandicum* and *Ledum palustre* constitute a well-developed medium shrub layer. *Vaccinium vitis-idaea* dominates a weakly-developed dwarf shrub-herb layer with associated *Rubus chamaemorus* and *Chamaedaphne calyculata*. The well-developed cryptogam layer, on a hummocky ground surface, is dominated by *Cladina mitis* in hollows and *Sphagnum fuscum* on hummocks.

Tree height ranges from 3.5 m to 9.0 m and dbh (diameter at breast height) varies from 4.5 to 11.0 cm. Tree core analysis indicates that *Picea mariana* became established approximately 50 years B.P. (before present). Most trees became established within 10 years after a fire, with little subsequent tree recruitment. Tree seedlings are absent and *Picea mariana* is not reproducing asexually by layering. Although fire-scarred trees were not observed in the stand, a few mature *P. mariana* were found at the edge of the community. Tree ring counts of these individuals gave an origin date of 97 years B.P. suggesting they had escaped the last fire. A charcoal layer in the soil profile also indicates a pattern of recurring fire and stand establishment.

This community is structurally and floristically similar to: (1) the *Picea mariana/Sphagnum* Open Heath and *Picea mariana*/Lichen Scrub community types from the northeastern region of the Cameron Hills (Fairbarns 1983); (2) to the *Picea mariana/ Sphagnum-Cladina* community in the Caribou Mountains (Lee et al. 1982); and (3) to the *Picea mariana/Sphagnum* spp.-*Cladina* spp. community type in Alaska (Foote 1983). Moss (1953a) also describes communities from the Steen River area and Caribou Mountains which are floristically similar. Permafrost features such as palsas, noted by Lee et al. (1982) and Moss (1953a) in the Caribou Mountains, are absent. However, further exploration of the Cameron Hills at higher elevations may reveal these features.

Betula pumila/Ledum groenlandicum-Ledum palustre/Vaccinium vitis-idaea/ Sphagnum spp. community

Stand 3 is an open shrub (i.e. scrubland) community (Fig. 8) which often forms a distinct band between lake shores or stream margins and open *Picea mariana* forests. Though clearly visible on the ground, this community type is too small to be mapped on a scale of 1:50000.

Betula pumila var. *glandulifera* is dominant as a moderately well-developed medium shrub layer. *Picea mariana* is infrequent and has very low cover. The strongly developed medium shrub layer is dominated by *Ledum groenlandicum* and *Ledum palustre*. *Vaccinium vitis-idaea* is well-developed in a dwarf shrub-herb layer where *Rubus chamaemorus* and *Oxycoccus microcarpus* are also prominent but have low cover. The moderately developed cryptogam layer is dominated by *Sphagnum fuscum*.

Populus tremuloides/Picea mariana/Shepherdia canadensis/Vaccinium vitis-idaea community

Stand 4 is a closed-canopy forest community located on moderately well drained clay soils derived from underlying till deposits. The tree canopy is dominated by *Populus tremuloides* with occasional individuals of *Picea mariana* (Fig. 9). By contrast, only *P. mariana* is well-developed in the tall shrub layer. *Salix* sp. is the only shrub species present in the tall shrub layer and it has low cover. The well-developed medium shrub layer is dominated by *Shepherdia canadensis* and *Rosa acicularis; Viburnum edule* and *Picea mariana* are prominent but have low cover. Important plants in the species-poor dwarf shrub-herb layer include *Vaccinium vitis-idaea, Linnaea borealis, Cornus canadensis* and *Mertensia paniculata*. The minor importance of cryptogams, primarily bryophytes, may be correlated with leaf litter development. Mosses, including *Hylocomium splendens, Dicranum fuscescens*, and *Brachythecium salebrosum,* are present but have very low cover.

The notable difference between this community and the *Populus tremuloides* Closed Forest described by Fairbarns (1983) is the presence of a well-developed tall shrub layer, consisting of *Alnus crispa* and *Salix* spp., in the latter. This layer was only weakly developed in the Bistcho stand.

Tree core analysis indicates that *Picea mariana* became established approximately 58 years B.P. The prominence of *Picea mariana* in the understory suggests that the stand is undergoing successional change. Given time and a disturbance-free environment, *P. mariana* will form the dominant tree cover. The nature of the parent material, and the stand's elevated topographic position, suggest that it will likely become an upland *P. mariana*/feathermoss

Map No.	Vegetation Types
1	*Populus tremuloides* with *Picea mariana* or *P. glauca* Closed Forest
2	*Picea glauca* Closed Forest
3	*Picea mariana* and/or *Picea glauca* Closed Forest
4	Open *Picea mariana*/*Ledum* spp. Woodland
5	*Populus tremuloides* Closed Forest
6	*Pinus banksiana*-*Populus tremuloides* Closed Forest
7	*Pinus banksiana* Closed Forest
8	Open Shoreline Shrub

Surveyed Stands = △

1:65,000

Figure 6. Vegetation types of the Bistcho Lake study area.

Table 1. Environmental attributes and species percent cover of the surveyed stands in the Bistcho Lake study area.

Stand No.	1	2	3	4	5	6
Slope	4	1	1	7	1	2
Aspect	NNW	NW	N	SW	SW	SW
Elevation	570	557	555	580	557	557
Soil Moisture	MH	X	M	M	X	M
Drainage	P	W	M	M	W	M
Soils	O. C.	E. B.	H. G.	G. L.	E. B.	E.B.
Trees						17
Picea glauca						
Picea mariana	10		1	1		
Pinus banksiana		15			0.5	
Populus tremuloides				15	10	5
Tall and Medium Shrubs		0.1				
Amelanchier alnifolia						
Betula pumila			8			
Ledum groenlandicum	6		5	0.5		
Ledum palustre	6		5			
Picea glauca		2			0.5	
Picea mariana				5		
Rosa acicularis		0.5		3	3	3
Salix bebbiana					0.5	
Salix sp.				0.5		
Shepherdia canadensis				4	0.5	1
Viburnum edule				1		2
Low Shrubs and Herbs			0.1			
Andromeda polifolia						
Arctostaphylos uva-ursi		8	0.5			
Carex gynocrates						
Chamaedaphne calyculata	1					
Corallorhiza trifida				0.1	0.5	0.1
Cornus canadensis		0.1		1		4
Elymus innovatus		0.5			2	0.5
Empetrum nigrum				0.5		
Epilobium angustifolium		0.5		0.5	0.5	0.5
Equisetum arvense		0.5				
Equisetum scirpoides		0.5				
Eriophorum vaginatum			0.5			
Fragaria virginiana		0.5			0.1	0.5
Galium boreale		0.5			0.5	
Geocaulon lividum	0.1	0.5		0.1		0.5
Goodyera repens						0.1
Juncus balticus		0.5				

cont.

Table 1. cont.

Stand No.	1	2	3	4	5	6
Lathyrus ochroleucus				0.5		
Linnaea borealis		0.5		2	2	10
Mertensia paniculata				1		2
Mitella nuda						0.5
Orthilia secunda		0.5		0.1		0.5
Orizopsis pungens		0.5				
Oxycoccus microcarpus	0.5					
Pyrola asarifolia				0.5		0.5
Pyrola chlorantha						0.5
Rubus chamaemorus	1		2			
Rubus pubescens						1
Senecio sp.		0.1				
Smilacina trifolia			0.5			
Solidago spathulata		0.5				
Vaccinium vitis-idaea	2	12	12	5	25	1
Bryophytes and Lichens						
Brachythecium salebrosum				0.5		
Cetraria nivalis	1	0.5	0.5			
Cladina mitis	70	40	1	0.5	0.5	
Cladina rangiferina	0.5	3				
Cladina stellaris		0.5				
Cladonia cornuta	0.5					
Cladonia gracilis	0.5	1				
Cladonia uncialis	0.5	5				
Cladonia sp.			1			
Dicranum fuscescens				0.5	0.5	
Dicranum undulatum	0.5	0.5	0.5			
Hylocomium splendens		0.5		1	0.5	60
Icmadophilia ericetorum	0.5					
Peltigera malacea		3				
Peltigera sp.			0.5			
Pleurozium schreberi	0.5					0.5
Polytrichum juniperinum	0.5		2			
Ptilidium ciliare		0.5				
Ptilium crista-castrensis	0.5				0.5	0.5
Sphagnum fimbriatum	0.5					
Sphagnum fuscum	10		3			
Sphagnum nemoreum	0.5					
Sphagnum warnstorfii			1			
Stereocaulon alpinum		0.5				
Tomenthypnum nitens			1			

1. Soil Moisture status: X = xeric, M = mesic, MH = mesic-hydric
2. Drainage: W = well, M = moderate, P = poor
3. Soils: O.C. = Organic Cryosol, E.B. = Eluviated Brunisol, H.G. = Humic Gleysol, G.L. = Gray Luvisol

Figure 7. Open *Picea mariana* woodland with an understory of well-developed ericaceous dwarf shrubs, *Sphagnum* spp. dominated hummocks, and lichen dominated hollows. *Picea mariana* is slowly becoming established on the cutline seen in the lower right corner.

Figure 8. Open *Betula pumila* scrubland community between Bistcho Lake shoreline and open *Picea mariana* woodland. *Betula pumila* forms a prominent, open, medium shrub layer. In the foreground, *Polytrichum juniperinum* dominates the moss carpet along the cutline.

Figure 9. A mature *Populus tremuloides* community developed on a till deposit. *Picea mariana* is prominent as an understory tree layer. The well-developed medium shrub layer is dominated by *Shepherdia canadensis.*

community rather than a *P. mariana/Sphagnum* community. Only a few small *P. mariana/* feathermoss communities exist in the area on similar upland sites; unfortunately none was sampled for their vegetation characteristics. A tree ring count from one of these sites indicates a stand origin date of approximately 148 years B.P. The small number and size of the *P. mariana*/feathermoss stands, and their relatively old age, suggest that these stands develop only in an undisturbed upland situation and that this condition is rarely met. Fire probably maintains the *Populus tremuloides/Picea mariana* community on upland till sites.

Picea glauca/Rosa acicularis/Cornus canadensis-Linnaea borealis/ Hylocomium splendens community

Located on the border of a till and outwash channel, Stand 6 is underlain by a mixture of sand and clay. *Picea glauca* is dominant in the tree layer, with *Populus tremuloides* present as a subdominant (Fig. 10). The medium shrub layer, composed of *Rosa acicularis, Viburnum edule,* and *Shepherdia canadensis*, is moderately well-developed. The dwarf shrub-herb layer is well-developed, with *Linnaea borealis, Cornus canadensis* and *Mertensia paniculata* as the leading species. The cryptogam layer, consisting primarily of *Hylocomium splendens,* is highly developed.

Tree ring analyses of *Picea glauca* cores indicate that this mature stand originated 113 years B.P. The stand appears to be even-aged, with tree ring counts varying from 113 for the largest individual (dbh = 37.3 cm, height = 22.7 m) to 102 for the smallest individual (dbh = 17.6 cm, height = 19.8 m). Neither *Populus tremuloides* nor *Picea glauca* show signs of regeneration and no new tree species are invading. In the absence of both fire and tree regeneration, this community appears to be succeeding to a non-perpetuating, monodominant *Picea glauca*/feathermoss stand.

Within Moss's (1953a) definition of a white spruce association, stand 6 would be considered an intermediate between a feathermoss faciation, in which *P. glauca* forms a closed canopy, and a shrub-herb faciation, having a mixed *P. glauca-P. tremuloides* canopy. The well-developed, but not continuous, feathermoss carpet suggests the feathermoss faciation while the moderately-developed shrub layer and well-developed herb layer suggest the shrub-herb faciation. According to Moss, the white spruce facia-

Figure 10. A mature *Picea glauca-Populus tremuloides* forest. *Linnaea borealis* and *Cornus canadensis* are prominent in the well-developed dwarf shrub-herb layer. Also evident is the absence of tree regeneration in the understory

Figure 11. Along a trail cutting through a young *Populus tremuloides* community near stand 5. Developed on a sandy parent material, the understory is dominated by dwarf shrubs. *Elymus innovatus* is prominent in this photo.

tions, in Alberta's boreal forest, are remarkable for their floristic and structural similarity.

Populus tremuloides/Vaccinium vitis- idaea/ Elymus innovatus community

Stand 5 occurs on well-drained sandy soils derived from glacial outwash and old beach ridge deposits. *Populus tremuloides* dominates the tree canopy, with scattered individuals of *Pinus banksiana* x *contorta* present but of minor importance (Fig. 11). *Picea glauca* occurs infrequently in the tall shrub layer. The understory is dominated by *Vaccinium vitis-idaea* in the dwarf shrub layer. *Elymus innovatus, Rosa acicularis, Linnaea borealis*, and *Epilobium angustifolium* are prominent but have substantially lower cover than *Vaccinium vitis-idaea. Cladina mitis, Dicranum fuscescens, Hylocomium splendens,* and *Pleurozium schreberi* are the leading species in the weakly-developed cryptogam layer.

This community may be ecologically similar to the *Populus-Rosa/Elymus* ecosystem described by Kabzems et al. (1976) for Saskatchewan. However, the Bistcho site is less species-rich and lacks a well-developed medium shrub layer. It is uncertain whether *P. tremuloides* can maintain itself indefinitely, via suckering, as in the Saskatchewan ecosystem type.

Pinus banksiana x contorta/Vaccinium vitis-idaea-Arctostaphylos uva-ursi/ Cladina mitis community

Stand 2, like the previous community, is underlain by sandy parent materials from glacial outwash and old beach ridge deposits. However, this community is more rapidly drained and thus more xeric.

The tree layer is composed entirely of a hybrid pine that has characteristics of both *Pinus banksiana* and *Pinus contorta* (Fig. 12). Most trees had readily identifiable *Pinus banksiana* attributes (i.e., cones directed towards the branch apex and cone scales without recurved prickles at maturity), however, some had attributes suggestive of *Pinus contorta* (i.e., spreading cones and cone scales with recurved prickles at maturity). Achuff (1974) reports hybrid populations of *P. contorta* and *P. banksiana* at lower elevations throughout northern and central Alberta.

The understory is dominated by an extensive lichen carpet, primarily *Cladina mitis* (60% cover), and ericaceous dwarf shrubs (20%) indicative of a very

Figure 12. Stand 2 is an open *Pinus banksiana* x *P. contorta* stand with a well-developed ericaceous dwarf shrub layer of *Vaccinium vitis-idaea* and a well-developed lichen carpet composed primarily of *Cladina mitis*

xeric site. Tall shrubs are absent and other forbs and dwarf shrubs are of minor importance.

Charcoal in the soil profile, multi-fire-scarred trees and distinct population age-classes of *Pinus banksiana* x *contorta* are evidence of the frequency and importance of fire in this community (Fig. 13). Tree ring counts indicate 2 major fires in recent times. The oldest trees date to 120 years B.P. while the cohort of younger trees date to 60 years B.P. Tree ring analysis suggests that the majority of tree establishment in the stand occurred within 10 years of the last fire, with in-filling occurring up to 25 years after fire.

This community contrasts with the mesophytic *Pinus contorta* Woodland and Open Forest described by Fairbarns (1983) from the northeastern Cameron Hills, where *Picea mariana* is prominent in the understory, the middle shrub layer is well developed, and the cryptogamic layer is poorly developed. Purchase and La Roi (1983) describe a xerophytic *Pinus banksiana/Rosa acicularis/Arctostaphylos uva-ursi-Lathyrus ochroleucus* community type, from the Fort Vermilion area, that is ecologically similar to Stand 2. However, the Bistcho Lake area differs from the Fort Vermilion area in that the former lacks *Lathyrus ochroleucus* and has a well-developed lichen carpet. Structurally, Stand 2 is very similar to the xerophytic *Pinus banksiana/Cladina mitis* described by Carroll and Bliss (1982) from northern Saskatchewan and northeastern Alberta. However, the vascular flora from the Bistcho site is more species-rich, indicating a more mesic moisture regime. Kabzems et al. (1976) described a *Pinus banksiana-Cladonia/Arctostaphylos uva-ursi* ecosystem from Saskatchewan that also shares ecological similarities with the Bistcho Lake site.

The 6 plant communities described above are representative of the major community types found throughout the study area. These community types share affinities with vegetation types described from both the northern boreal and boreal subarctic ecoregions (Strong and Leggat 1981).

Figure 13. Fire is an important factor influencing the development of vegetation in the Bistcho Lake area. The 3 scars at the blackened base of this 120 + year old pine indicate it has survived three fires. Few pines in the boreal forest are as long-lived or survive as many fires.

FLORA OF THE BISTCHO LAKE AREA

General Flora

In 1974, Provincial Museum staff did a brief collecting trip to Thurston Lake, in the Cameron Hills, but did not publish their results (J.O. Hrapko, pers. comm.). The only published, floristic work done in the Bistcho Lake region is Fairbarns' (1983) report on a proposed Natural Area in the Cameron Hills. These hills are a part of the Alberta Plateau that includes Bistcho Lake, although the hills are about 200 - 350 m higher in elevation than the lake.

In this study of the Bistcho Lake area, 203 plant taxa were found compared to 236 reported by Fairbarns for the Cameron Hills. The 149 vascular taxa in the Bistcho Lake list include 10 pteridophytes, 5 gymnosperms, 58 monocots and 96 dicots (Appendix 1). For the Cameron Hills, 176 vasculars, including 9 pteridophytes, 5 gymnosperms, 55 monocots and 106 dicots were reported. The list of non-vascular flora of Bistcho Lake comprises 54 species, including 30 lichens, 22 mosses and 2 hepatics (Appendix 2). Fairbarns reported 57 non-vasculars with 23 lichens, 31 mosses and 3 hepatics. The slightly higher species richness reported from the Cameron Hills is likely due to the greater habitat diversity in the latter area. Especially evident is the lack of rich fens around Bistcho Lake.

Bistcho Lake Flora Rare in or New to Alberta

Two species that are rare in and 1 variety that is new for the province were found in the Bistcho Lake area. *Arctagrostis arundinacea* (Trin.) Beal was found growing on moist sandy soil along a cutline through a black spruce forest. The cutline was overgrown with *Betula* and *Salix* shrubs. Packer and Bradley (1984) classify *A. arundinacea* as rare in Alberta and show that it has been collected only once in the Jasper area and twice near or on the south escarpment of the Caribou Mountains. Fairbarns (1983) reports that the species was "frequent and occasionally abundant in moist *Picea mariana* forests and peatlands" of the Cameron Hills. The Bistcho Lake specimen appears to be the fifth collection of this species in Alberta. Porsild and Cody (1980) state that *A. arundinacea* is an "Amphi-Beringian species which from E. Siberia extends through Alaska and Y.T. a short distance east of the Mackenzie Delta and in the mountains south into northernmost Alta. and B.C.". Hultén (1968) also shows the species to have an amphi-Beringian distribution. The occurrence of *A. arundinacea* in the Bistcho Lake flora, the Cameron Hills and the Caribou Mountains, suggests a connection between the Alberta Plateau uplands and the Beringial Alaskan-Cordilleran flora. *A. arundinacea* may have dispersed from the Beringial refugia of Alaska-Yukon in post-glacial times when tundra communities were more widespread in northwestern Canada.

The second rare species from the Bistcho Lake area is *Pinquicula villosa* L. It was found growing on *Sphagnum fuscum* hummocks in two open *Picea mariana/Ledum/ Sphagnum* bogs. Packer and Bradley (1984) classify this species as rare in Alberta; their only record being a collection from the Caribou Mountains. However, *P. villosa* was reported by Fairbarns (1983) as "frequent in *Sphagnum* hummocks in bogs" in the Cameron Hills. The Bistcho Lake collection is the third verified report of this species in Alberta. Given the widespread occurrence of the *P. mariana/Ledum/Sphagnum* community type in the Boreal Subarctic ecoregion of northern Alberta (Strong and Leggat 1981) it may be expected that *P. villosa* will be found to be more common than the current literature suggests. The small size of the plant and the remoteness and ruggedness of its habitat have led to the under-collection of this species in Alberta. As the Buffalo Head Hills are a part of the Boreal Subarctic ecoregion, along with the Caribou Mountains and the Cameron Hills (Strong and Leggat 1981), it may be expected that this species occurs as far south as these hills. *P. villosa* is shown by Hultén (1968) and Porsild and Cody (1980) to be a wide ranging, circumpolar, subarctic species found on hummocks in peat bogs. The occurrence of this plant in the Bistcho flora indicates the affinity of the area with more northerly subarctic ecosystems.

Specimens of *Equisetum hyemale* L. were collected in a *Pinus banksiana-Populus tremuloides* stand situated on dry, sandy soil about 2 km from the lakeshore. The stand is on sand dunes which probably developed from proglacial meltwater deposits. Moss and Packer (1983) report that in Alberta the variety of *E. hyemale* is *affine* (Engelm.) A.A. Eat. However, specimens from the Bistcho area have 2 rows of silica tubercles on the ridges of the stem rather than a single bar as in var. *affine*. Thus our specimen best fits var. *californicum* Milde as described by Hultén (1968). Variety *californicum* is considered to be the

Alaskan-Western North American variety of this extremely variable species complex (Hultén 1968). This may be another link of the Bistcho Lake flora to an Alaskan-Cordilleran (Beringial?) flora. However, given that identification of this variety is based on a microscopic examination of a difficult to see feature, and that the species is extremely variable morphologically, further confirmation is needed. An investigation of *E. hymale* specimens in the Provincial Museum herbarium revealed a specimen from southwest of Fort McMurray which, although classified as var. *affine*, appears to have the 2 rows of silica tubercles of var. *californicum*.

Vascular Plants New to Northwestern Alberta

There are no roads into and no river courses traverse the northwestern part of Alberta. Thus collecting has been very limited; the area was not covered in the classic works of Moss (1953a, b) and Raup (1935, 1936, 1946). Thus, it is not surprising that an additional 43 vascular taxa found in the Bistcho Lake study area are reportedly new to northwestern Alberta according to Moss and Packer (1983). Virtually all these taxa have been reported in the southern Northwest Territories and/or in northeastern British Columbia. Their geographic significance lies primarily in filling gaps in their known or predicted distributions in Alberta and not in great northerly or southerly extensions of their total range. Where noted with an * these taxa were also reported by Fairbarns (1983) for the Cameron Hills.

The largest group of taxa new to northwestern Alberta have previously been reported no further north than along the Peace and Slave Rivers. This group consists of 15 taxa, 9 of which were also reported by Fairbarns (1983). These taxa are:

> *Lycopodium annotinum**, *Festuca saximontana**, *Oryzopsis pungens**, *Poa pratensis**, *Calypso bulbosa*, *Salix myrtillifolia**, *Urtica dioica* spp. *gracilis*, *Cerastium arvense*, *Actaea rubra**, *Thalictrum venulosum*, *Geranium bicknellii*, *Viburnum edule**, *Hieracium umbellatum**, *Petasites sagittatus**, and *Solidago spathulata*.

The distributions of 3 of these taxa are especially notable. According to Hultén's (1968) map, Bistcho Lake is near the northern limit of the continuous distribution of *Oryzopsis pungens* (Torr.) A.S. Hitchc. in western Canada. Populations of this species are found around Great Slave Lake and a disjunct group has been reported on the east shore of Great Bear Lake (Hultén 1968, Porsild and Cody 1980). Bistcho Lake appears to connect the Great Slave Lake populations with those reported in the extreme southeastern Yukon and northeastern British Columbia.

Cerastium arvense L. is a circumpolar plant, of dry sites, reported to have a weedy habit (Porsild and Cody 1980). With the exception of populations in the southern Yukon and along coastal Alaska, Bistcho Lake is north of the species' continuous distribution in western North America. The habitats in which *Cerastium arvense* was collected at Bistcho Lake suggest that this species has dispersed into the area with the advent of human activity. The first collection site was on dry, sandy soil at the end of an airstrip servicing a fishing lodge on the lake. The airstrip had recently been cleared and the stand had been burned. The second site was near abandoned trappers' cabins on the Bistcho Lake Indian Reserve. The area around the cabins is a disturbed grassland, on sandy soil, which is clear of trees.

Geranium bicknellii Britt. is also a plant of disturbed habitats (Hultén 1968, Porsild and Cody 1980, Moss and Packer 1983). At Bistcho Lake the plant was collected with *C. arvense* near the airstrip. The maps of Hultén (1968) and Porsild and Cody (1980) both suggest that this species is distributed mainly through the central and southern boreal forest, with a disjunct population in the Lake Athabasca-Great Slave Lake area. The specimens collected at Bistcho Lake are intermediate to these 2 populations and suggest that the distribution of *G. bicknellii* is more continuous than is shown in the literature. The occurrence of this species in northerly areas likely is dependent on fire and human disturbance. *G. bicknellii* is often noted after a severe fire, suggesting that it is maintained in the seed bank until released by some disturbance. Neither *C. arvense* nor *G. bicknelli* are reported to occur in the Cameron Hills, an area with little recent disturbance (Fairbarns 1983). Further, there has probably been less human activity in the Cameron Hills than around Bistcho Lake. Bistcho Lake has several commercial fishing lodges and until the 1950s it was used by native trappers. Thus the probability of weed species occurring in the Bistcho flora is greater than in the Cameron Hills.

The second-largest group of plants new to the northwestern corner of Alberta include 10 taxa re-

ported as occuring only southward from the Peace River area and from Wood Buffalo National Park (Moss and Packer 1983). These 10 taxa, in contrast to the first group, have not been reported along the Peace River between the town of Peace River and Wood Buffalo National Park. These species are:

Lycopodium clavatum, Potamogeton richardsonii, Carex siccata, Carex vaginata*, Juncus balticus, Populus balsamifera**, Betula *papyrifera* var. *subcordata, Potentilla pennsylvanica, Androsace septentrionalis,* and *Campanula rotundifolia.*

A group of 3 species collected at Bistcho Lake is known to occur in Alberta as far north as High Level and Wood Buffalo National Park but have not been reported between these 2 areas (Moss and Packer 1983). These are:

Nuphar variegatum, Astragalus eucosmus, and Phacelia franklinii.*

Two of these species are noteworthy. *Nuphar variegatum* Engelm. is wide-ranging throughout the boreal forest of eastern Canada and extends northward as far as Great Bear Lake and westward into the southeastern Yukon Territory (Hultén 1968, Porsild and Cody 1980). Bistcho Lake is near the western edge of the distribution of this species. To the west and northwest *N. variegatum* is replaced by the Alaskan-Cordilleran *N. polysepalum* Engelm..

Phacelia franklinii (R. Br.) A. Gray is a wide-ranging boreal forest species often found on dry, disturbed sites (Hultén 1968, Porsild and Cody 1980, Moss and Packer 1983). At Bistcho Lake this species was common beside the airstrip where the forest had been cleared and burned. As was true for the other species characteristic of disturbance habitats, this taxon was not reported in the Cameron Hills (Fairbarns 1983).

The common feature in the reported distribution of the fourth group of plants is that they are wide-ranging throughout central and northern Alberta but are not known from the Bistcho Lake area (Moss and Packer 1983). These 8 species are:

Botrychium lunaria, Potamogeton alpinus, Carex concinna, Goodyera repens, Ribes glandulosum, Myriophylum exalbescens*, Andromeda polifolia**, and *Utricularia minor.*

Moss and Packer (1983) show *Botrychium lunaria* (L.) Sw. occurring in montane areas, central Alberta, the Grande Prairie region, the Fort McMurray region, and Wood Buffalo National Park. Hultén (1968) and Porsild and Cody (1980) show *B. lunaria*, in western North America, as largely Alaskan-Cordilleran with a disjunct population along the Slave River between Lake Athabasca and Great Slave Lake. The discovery of *B. lunaria* at Bistcho Lake is significant for 2 reasons. First, it is a major extension of the known range of the species in Alberta. Second, the population at Bistcho Lake fills the geographic gap between the reported disjunct populations along the Slave River and their main Cordilleran group. The presence of this species in northwestern Alberta, along with reports of the species in central Alberta and Fort McMurray (Moss and Packer 1983), suggests that the Slave River population may not be disjunct and that the species may range from the Cordillera to Lake Athabasca in dry, grassy places along lake shores or outwash channels.

Like *B. lunaria*, the discovery of *Utricularia minor* L. at Bistcho Lake may help link an eastern population to an Alaskan-Cordilleran population. Moss and Packer (1983) show *U. minor* occurring in a few montane locales, around Lesser Slave Lake, and in the Wood Buffalo National Park area. The population nearest to Bistcho Lake is in Wood Buffalo National Park. *U. minor* has 2 distinct populations: an Alaskan-Cordilleran group and a second large population that crosses boreal Canada from Newfoundland to Great Slave and Great Bear Lakes (Hultén 1968). The Bistcho population appears to be on the western edge of the continental population. However, Porsild and Cody (1980), record *U. minor* near Nahanni in the southwestern Northwest Territories, northwest of Bistcho Lake. These 2 collections, although separated by a considerable distance, indicate that the 2 populations of *U. minor* may form 1 continuous distribution across boreal Canada reaching into the Cordillera of the Yukon and Alaska.

Seven taxa were collected which have a predominantly arctic-alpine or subarctic-subalpine distribution. In Alberta these species have been recorded primarily in the mountains although they may range into the boreal forest (Moss and Packer 1983). These taxa are:

Calamagrostis purpurascens ssp. *purpurascens, Carex atrosquama, Carex capitata, Luzula multiflora*, Luzula parviflora*, Draba aurea*, and *Senecio streptanthifolius.*

In Alberta, *Calamagrostis purpurascens* R. Br. ssp. *purpurascens* is reported only from alpine areas and Wood Buffalo National Park (Moss 1983). From the maps of Hultén (1968) and Porsild and Cody (1980) it appears that the northern populations, from Wood Buffalo National Park and Bistcho Lake, are probably southern extensions of arctic-subarctic populations rather than northern extensions from Alberta's alpine regions. Both authorities show northern populations close to the Bistcho Lake area. The occurrence of this arctic species in the Bistcho Lake flora shows the relationship of the area to more northern ecosystems.

Carex capitata L. is located in a few scattered subalpine locales in Alberta with populations along the Athabasca River as far north as Whitecourt. In Alberta, the Whitecourt population appears to be closest to the Bistcho population. However, Hultén (1968) shows *C. capitata* to be a wide-ranging subarctic-subalpine species which has a non-alpine southern limit close to Bistcho Lake. The presence of this species, along with *C. purpurascens*, shows a subarctic influence on the Bistcho Lake flora.

Moss and Packer (1983) show *Carex atrosquama* Mack. occurring in the alpine-subalpine region in Alberta as far north as Grande Cache. The occurrence of this species at Bistcho Lake is a highly significant range extension within the province. Hultén (1968) shows this species to be strictly Cordilleran except for a disjunct population at Great Bear Lake. It appears that *C. atrosquama* at Bistcho Lake is also a disjunct population and may be a significant range extension for this species in western Canada.

Draba aurea Vahl. is another species with a strongly subalpine distribution in Alberta. It ranges into the boreal uplands and foothills and is shown as far north as Spirit River (Moss and Packer 1983). The Bistcho population is a significant range extension for this species in Alberta. Hultén (1968) shows *D. aurea* to be more wide-ranging than *C. atrosquama*, occurring around the shores of Great Slave and Great Bear Lakes as well as in the eastern subarctic. However, outside of the Cordilleran areas its distribution is characterized by scattered, isolated populations. The population at Bistcho could be either an extension of the subalpine populations or it could be related to the isolated groups in the southern Northwest Territories.

In Alberta, *Senecio streptanthifolius* Greene is found predominantly in the Cordilleran region but it is also reported in the Peace River area, near High Level, and in Wood Buffalo National Park. While the occurrence of this species at Bistcho Lake is not surprising given this distribution, it is biogeographically significant. Hultén (1968) shows *S. streptanthifolius* (syn. = *S. cymbalariodes* Nutt.) as almost exclusively Cordilleran, with a large disjunct population ranging from the Slave River to Great Bear Lake. Given the central location of the Bistcho Lake population between these 2 distributions and the fact that the species is distributed from Wood Buffalo National Park, through Bistcho Lake, High Level, Peace River and then to the Whitecourt and Jasper areas, it seems reasonable to suggest that the range of this species is continuous. That is, the large "disjunct" Northwest Territories population is actually continuous with the main Cordilleran population.

Phytogeography of the Bistcho Lake Flora

Vascular Flora

To describe the biogeography of the Bistcho Lake flora, the North American distributions of the region's taxa were classified according to Raup's (1947) system. Originally, Raup had devised his classification to discuss the geographic affinities of the Brintnell Lake flora in the southwestern Northwest Territories with the floristic provinces of boreal North America. In turn, Raup's classification was modified from Hultén's (1937) work on the circumpolar Quaternary flora.

In this study vascular plants which could be identified only to the generic level, largely due to lack of flowers or fruits, are excluded from analysis. The hybrid taxon *Pinus banksiana* x *contorta* was not included due to limited knowledge about its range and taxonomic status.

The ranges of 143 vascular plant species are considered here. Sixty-five of these species also occurred in the Brintnell Lake study and were thus, initially, classified into ranges assigned to them by Raup (1947). Using the maps and written descriptions of the ranges in Raup, the remaining 78 species were assigned distribution ranges. The maps in the floras of Hultén (1968) and Porsild and Cody (1980) were used to determine the species ranges. Finally, the ranges of the 65 species classified by Raup were checked against Hulténs' and Porsild and Codys' floras.

Twelve of the 65 species have ranges different from those reported by Raup. Eleven of the 12 differences can be attributed to extensions in the known species ranges. One extension is due to a species, formerly thought to be subarctic, being found in the Canadian Arctic Islands. Three extensions are due to species, thought to be limited below treeline, being found in the tundra. Eight extensions are due to species having increased ranges along the Pacific coastal mountains, with 2 of these species also having range extensions into the tundra. These extensions are reasonable in light of increased exploration of the arctic and remote areas of the coastal mountains since Raup's 1947 study.

Poa pratensis L. was classified by Raup (1947) as a wide-ranging forest species that extends far into the tundra. The closely related *Poa alpigena* (Fr.) Lindm. is a wide-ranging arctic-alpine species that, at the time of Raup's work, was classified as a subspecies of *P. pratensis* (cf. Porsild 1957). With recent taxonomic revisions these are now accepted as 2 species. The range of *P. pratensis* is accepted as being non-arctic (Porsild and Cody 1980). The range of this species was changed from Raup's classification to match those shown in more recent floras.

The flora of Bistcho Lake falls into 7 main distributions including Raup's original 6 and 1 additional grassland/parkland range (Appendix 3). These ranges, described in detail in Raup (1947), are briefly outlined here. The classification applies only to Alaska and Canada; many of these species occur in Europe and Asia and some are found in the southern hemisphere.

1) Wide-Ranging Forest species - these species have their main distribution in the "Canadian coniferous forest, and whose ranges are wide in this region, extending for the most part all the way across the continent" (Raup 1947). Some members of this group extend into the low arctic tundra but are not found in the Arctic islands.

2) Wide-Ranging Arctic-Alpine species - these species extend through the Canadian Arctic islands or occur in Cordilleran alpine areas. While their ranges are concentrated above the treeline/timberline some species in this group are found in forested areas.

3) Wide-Ranging Subarctic-Subalpine species - called Timber Line species by Raup, these species are a difficult group to classify as they extend across the continent near the treeline and, while they extend into the tundra, they are not found in the Arctic islands. They are found in the northern boreal forest but mostly in muskeg or other poor habitats.

4) Alaskan-Cordilleran species - these species are not wide-ranging but are found in tundra and forested environments in northwestern North America. They may reach the Arctic coast in Alaska although some are entirely continental.

5) Cordilleran species - this group consists of species which do not reach the Arctic coast in Alaska or Canada and don't extend out onto the Great Plains. They range from the northern Cordillera, but only in the very southern part of Alaska, down through the mountains of the western United States.

6) Cosmopolitan species - these wide-ranging species are found in nearly all parts of the arctic, subarctic, and forested areas of North America.

7) Grassland/parkland species - this category was not included by Raup in his analysis of the Brintnell Lake flora. A single weedy species, *Arabis glabra* (L.), Bernh. from Bistcho appears to be predominantly from the prairies with extensions into northern habitats.

It is evident from the above descriptions that these floristic areas are not mutually exclusive and that a fair degree of overlap exists among them. Nevertheless, accepting that some "errors" in classification will be made, both from human judgement about species ranges shown on maps and from lack of information about the total range of a given species, it is possible to classify the flora of Bistcho Lake into these 7 distributions and even further into their 14 subdivisions (Appendix 3). Classification into these distributions gives some idea about the geographic affinities of the flora of Bistcho Lake. Table 2 is a dichotomous key which classifies the flora into the 7 major distributions. The numbers in the key correspond to those given in the text above.

The most difficult and ambiguous separation is between "Wide-Ranging Forest species" and "Wide-Ranging Arctic-Alpine species". Written descriptions of the habitats of these species from the floras' of Hultén (1968), Porsild and Cody (1980) and Moss and Packer (1983), sparse though they are, proved most valuable in classifying a species as subarctic. For the purposes of this project a conservative view was taken in classifying a species as subarctic and

Table 2. Dichotomous key to the floristic regions of the Bistcho Lake flora.

A) Wide-ranging across the continent (1,2,3,6,7)	C
Western North America, rarely on Great Plains (4,5)	B
B) Alaskan and Cordilleran, often Arctic coastal	4
Cordilleran, only minor in Alaska, never Arctic coastal	5
C) Distribution mostly south of boreal forest, never arctic	7
Distribution boreal forest and/or arctic (1,2,3,6)	D
D) Found on Canadian Arctic islands, may be into boreal (2,6)	E
Not on Canadian Arctic islands (1,3)	F
E) Range from Canadian Arctic islands to SE United States	6
Range from Canadian Arctic islands into boreal forest	2
F) Broad boreal belt, may extend well beyond treeline	1
Northern third of boreal forest, boreal peatlands and low arctic tundra	2

preference was generally given to calling a taxon a "Wide-Ranging Forest/Tundra species" rather than as a "Wide-Ranging Subarctic-Subalpine species". The reason for this approach is that the broad regional maps of both Hultén and Porsild and Cody are from floras written for Alaska, the Yukon, and the Northwest Territories. Given the regional nature of these floras, it is to be expected that the southern boreal limits of these species will not be so well mapped as the northern limits. This potentially biases the classification towards subarctic ranges. Indeed Porsild and Cody's (1980) work contains many omissions in species ranges outside of the continental Northwest Territories. By taking a conservative approach, more weight was given to a boreal forest affinity for the Bistcho Lake flora rather than forcing what may be an artificial subarctic affinity onto the area.

The largest floristic group found in the Bistcho Lake area belongs to the "Wide-Ranging Forest species" group. Just over 80% of the flora, 115 taxa, are distributed throughout the forest regions of Canada, though some extend from the forests into tundra regions. The largest single subgroup within this forest group (38 species, 33% of forest species, 27% of total) are strictly continental species found only below treeline. These species are classic boreal forest plants (e.g., *Picea glauca* and *Mertensia paniculata*). Ninety-two species (80% of forest species, 64% of total) found around Bistcho Lake are limited by treeline, though they may range into the Pacific coastal mountains. By comparison, 20% of the forest species also have populations in low arctic tundra or alpine tundra habitats (e.g., *Rubus chamaemorus*, *Vaccinium vitis-idaea*).

The second largest group, with 14 taxa, are the "Wide-Ranging Subarctic-Subalpine species" comprising just under 10% of the flora. The third largest group, with 6 species, is the "Wide-Ranging Arctic-Alpine species" group. This group makes up about 4% of the Bistcho Lake flora. Cordilleran-continental and Alaskan-cordilleran taxa make up 2% and 0.7% of the flora respectively. In total (excluding cosmopolitan), 16.8% of all vascular taxa from the Bistcho Lake area have dominantly arctic-subarctic or alpine-subalpine distributions. With the addition of the groups of wide-ranging forest species which have populations in arctic environments, about 33% of the Bistcho Lake flora has an arctic-subarctic affinity.

Thus, on the basis of this floristic analysis, it appears that the vascular flora of the Bistcho Lake area is predominantly from boreal forest with a significant incursion of arctic-subarctic elements. The arctic-subarctic element is even more evident in the vegetation of the area. For example, *Rubus chamaemorus*, *Empetrum nigrum*, *Ledum groenlandicum*, *Andromeda polifolia* and *Vaccinium vitis-idaea* are wide-ranging boreal forest plants with arctic-subarctic populations; and *Ledum palustre* and *Eriophorum vaginatum* are predominantly subarctic-subalpine plants, all of which are common in the Bistcho Lake area.

Bryophyte Flora

Unfortunately, literature on the biogeography of mosses and hepatics is very limited; few studies give a continental or subcontinental perspective. One exception is Schofield (1969) who classified the mosses and hepatics of western North America into wide

biogeographical provinces. According to his classification virtually all bryophytes from the Bistcho Lake area are circumboreal (Appendix 2). Only one moss, *Dicranum elongatum*, can be classified as arctic-alpine and this species also has a circumboreal distribution.

The bryophyte flora collected on this expedition is typical of that expected in a broad sweep of the northern boreal forest of Alberta (D.H. Vitt, pers. comm.). According to him there are no biogeographically significant taxa among the collected mosses or hepatics.

Lichen Flora

Until recently there was no regional biogeographic study that encompassed most of the lichens found in northern Alberta. Fortunately, with the publication of Thomson's (1984) book, *American Arctic Lichens*, it is now possible to classify most lichens found in the Bistcho Lake area into broad biogeographical realms. These realms are similar to those of vascular vegetation (Crum 1966).

Using Thomson (1984), the lichens of Bistcho fall into 4 realms: arctic-alpine, low arctic-boreal, boreal, and temperate. Several lichen species are wide-ranging and fall into 2 or more of these realms. Virtually all have a circumpolar distribution.

Of the 28 lichens from Bistcho Lake that were identified to species, 16 (57%) are found primarily in the low arctic-boreal zone (Appendix 2). Nine species (32%) are considered to be primarily from arctic-alpine areas but, of these, only *Stereocaulon alpinum* is almost exclusively from above timberline. The remaining species with arctic affinities are also found in the boreal forest and some of these occur in temperate regions. Only 2 species are considered to be almost strictly boreal with few reports in either arctic or temperate regions. *Evernia mesomorpha* is epiphytic on conifers and thus is restricted in its northern range by the limits of treeline. Ten species (35.7%) of lichens have ranges that include the temperate region as well the boreal forest.

Lichen phytogeography, like that of the vascular flora, appears to support the contention that the Bistcho Lake area is composed primarily of plants from the northern boreal forest with significant incursions of arctic floristic elements.

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Lycopodiaceae	
Lycopdium annotinum L.	Stiff Club-moss
Lycopodium clavatum L.	Running Club-moss
Lycopodium complanatum L.	Ground Cedar or Trailing Club-moss
Equisetaceae	
Equisetum arvense L.	Common Horsetail
Equisetum fluviatile L.	Swamp Horsetail
Equisetum hyemale L	Common Scouring-rush
Equisetum pratense Ehrh..	Meadow Horsetail
Equisetum scirpoides Michx.	Dwarf Scouring-rush
Equisetum sylvaticum L.	Woodland Horsetail
Ophioglossaceae	
Botrychium lunaria (L.) Sw.	Moonwort
Pinaceae	
Larix laricina (Du Roi) K. Koch	Tamarack
Picea glauca (Moench) Voss	White Spruce
Picea mariana (Mill.) BSP.	Black Spruce
Pinus banksiana x *contorta*	Hybrid Pine
Pinus banksiana Lamb.	Jack Pine
Potamogetonaceae	
Potamogeton sp.	Pondweed
Potamogeton alpinus Balbis	Alpine Pondweed
Potamogeton richardsonii (Benn.) Rydb.	Richardson's Pondweed
Gramineae	
Agropyron sp.	Wheat Grass
Arctagrostis arundinaceae (Trin.) Beal.	Polar Grass
Calamagrostis canadensis (Michx.) Beauv. ssp. *langsdorfii* (Link) Hult.	Marsh Reed Grass
Calamagrostis purpurascens R.Br. ssp. *purpurascens*	Purple Reed Grass
Elymus innovatus Beal	Hairy Wild Rye
Festuca saximontana Rydb.	Rocky Mountain Fescue
Glyceria sp.	Mama Grass
Oryzopsis pungens (Torr.) A.S. Hitchc.	Northern Rice Grass
Poa interior Rydb.	Inland Blue Grass
Poa pratensis L.	Kentucky Blue Grass
Cyperaceae	
Carex sp.	Sedge
Carex aenea Fern.	Bronze Sedge
Carex aquatilis Wahlenb.	Water Sedge
Carex atrosquama Mack.	Dark-scaled Sedge
Carex aurea Nutt.	Golden Sedge
Carex brunnescens (Pers.) Poir. var.	Brownish Sedge

cont.

Carex brunnescens (Pers.) Poir. var. *brunnescens*	Brownish Sedge
Carex capillaris L. ssp.	Hair-like Sedge
Carex capillaris L. ssp. *capillaris* L.	Hair-like Sedge
Carex capitata L.	Capitate Sedge
Carex concinna R.Br.	Elegant Sedge
Carex disperma Dewey	Two-seeded Sedge
Carex gynocrates Wormsk,	Northern Bog Sedge
Carex rostrata Stokes	Beaked Sedge
Carex siccata Dewey	Hay Sedge
Carex vaginata Tausch	Sheathed Sedge
Eriophorum vaginatum L.	Sheathed Cotton Grass
Juncaceae	
Juncus sp.	Rush
Juncus balticus Willd.	Wire Rush
Luzula multiflora (Retz.) Lej.	Field Wood-rush
Luzula parviflora (Ehrh.) Desv.	Small-flowered Wood-rush
Liliaceae	
Smilacina stellata (L.) Desf.	Star-flowered Solomon's-seal
Orchidaceae	
Calypso bulbosa (L.) Oakes	Calypso Orchid or Venus'-slipper
Corallorhizza trifida Chatelain	Pale Coral-root
Goodyera repens (L.) R.Br.	Lesser Rattlesnake-plantain
Habenaria obtusata (Pursh) Richards	Blunt-leaved Bog Orchid
Orchis rotundifolia Banks ex. Pursh	Round-leaved Orchid
Spiranthes romanzoffiana Cham. & Schlect.	Ladies'-tresses
Salicaceae	
Populus balsamifera L.	Balsam Poplar
Populus tremuloides Michx.	Aspen Poplar
Salix bebbiana Sarg.	Beaked Willow
Salix glauca L.	Grayleaf Willow
Salix myrtillifolia Anderss.	Myrtle-leaved Willow
Betulaceae	
Alnus tenuifolia Nutt.	River Alder
Betula papyrifera Marsh *var. subcordata* (Rydb.) Sarg.	White Birch or Paper Birch
Betula pumila L.	Swamp Birch
Urticaceae	
Urtica dioica L. ssp. *gracilis* (Ait.) Selander	Common Nettle
Santalaceae	
Geocaulon lividum (Richards.) Fern.	Northern Bastard Toadflax
Chenopodiaceae	
Chenopodium capitatum (L.) Aschers.	Strawberry Blite

cont.

Caryophyllaceae	
Cerastium arvense L.	Mouse-ear Chickweed
Stellaria longifolia Muhl.	
Stellaria longipes Goldie	Long-stalked Chickweed
Nymphaeaceea	
Nuphar variegatum Engelm.	Yellow Pond-lily
Ranunculaceae	
Actaea rubra L.	Red Baneberry or White Baneberry
Ranunculus gmelinii DC.	Yellow Water Crowfoot
Thalictrum venulosum Trel.	Veiny Meadow-rue
Fumariaceae	
Corydalis aurea Willd.	Pink Corydalis
Cruciferae	
Arabis glabra (L.) Bernh.	Tower Mustard
Draba aurea Vahl.	Golden Whitlow-grass
Saxifragaceae	
Chrysosplenium tetrandrum (Lund) T. Fries	Golden Saxifrage
Mitella nuda L.	Bishop's-cap
Parnassiaceae	
Parnassia palustris L.	Northern Grass-of-Parnassus
Grossulariaceae	
Ribes glandulosum Grauer	Skunk Currant
Ribes hudsonianum Richards	Wild Black Currant
Ribes oxycanthoides L.	Wild Gooseberry
Ribes triste Pall.	Wild Red Currant
Rosaceae	
Amelanchier alnifolia Medic.	Saskatoon
Fragaria virginiana Duchesne	Wild Strawberry
Geum macrophyllum Willd. ssp. *perincisum* (Rydb.) Hult.	Yellow Avens
Potentilla sp.	
Potentilla fruticosa L.	Shrubby Cinquefoil
Potentilla norvegica L.	Rough Cinquefoil
Potentilla palustris (L.) Scop.	Marsh Cinquefoil
Potentilla pensylvanica L.	Prairie Cinquefoil
Rosa acicularis Lindl.	Prickly Rose
Rubus arcticus L.	Dwarf Raspberry
Rubus chamaemorus L.	Cloudberry
Rubus idaeus L.	Wild Red Raspberry
Rubus pubescens Raf.	Dewberry

cont.

Leguminosae	
Astragalus americanus (Hook.) M.E. Jones	American Milk-vetch
Astragalus eucosmus Robins.	Elegant Milk-vetch
Lathyrus ochroleucus Hook.	Vetchling
Oxytropis deflexa (Pall.) DC.	Reflexed Loco-weed
var. *sericea* T. & G.	
Vicea americana Muhl.	Wild Vetch
Geraniaceae	
Geranium bicknellii Britt.	Bicknell's Geranium
Empetraceae	
Empetrum nigrum L.	Crowberry
Violaceae	
Viola renifolia A. Gray	Kidney-leaved Violet
Elaeagnaceae	
Shepherdia canadensis (L.) Nutt.	Canadian Buffaloberry
Onagraceae	
Epilobium angustifolium L. ssp *angustifolium*	Fireweed
Haloragaceae	
Myriophylum exalbescens Fern.	Spiked Water-milfoil
Hippuridaceae	
Hippurus vulgaris L.	Mare's-tail
Umbelliferae	
Cicuta maculata L.	Water-hemlock
Sium sauve L.	Water Parsnip
Cornaceae	
Cornus canadensis L.	Bunchberry
Cornus stolonifera Michx.	Red-osier Dogwood
Pyrolaceae	
Moneses uniflora (L.) A. Gray	One-flowered Wintergreen
Orthilia secunda (L.) House	One-sided Wintergreen
Pyrola asarifolia Michx.	Common Pink Wintergreen
Pyrola chlorantha Sw.	Greenish-flowered Wintergreen
Ericaceae	
Andromeda polifolia L.	Bog-rosemary
Arctostaphylos rubra (Rehder & Wils.) Fern.	Red Alpine Bearberry
Arctostaphylos uva-ursi (L.) Spreng.	Common Bearberry
Chamaedaphne calyculata (L.) Moench	Leather-leaf
Ledum groenlandicum Oeder	Common Labrador Tea
Ledum palustre L.	Northern Labrador Tea
Oxycoccus microcarpus Turcz.	Small Bog Cranberry

cont.

Vaccinium uliginosum L.	Bog Bilberry
Vaccinium vitis-idaea L.	Bog Cranberry
Primulaceae	
Androsace septentrionalis L.	Fairy Candelabra or Pygmy-flower
Trientalis borealis L.	Star-flower
Gentianaceae	
Gentianella sp.	Gentian
Hydrophyllaceae	
Phacelia franklinii (R.Br.) A. Gray	Franklin's Scorpionweed
Boraginaceae	
Mertensia paniculata (Ait.) G. Don.	Tall Mertensia
Labiatae	
Dracocephalum parviflorum Nutt.	American Dragonhead
Scutellaria galericulata L.	Common Skullcap
Scrophulariaceae	
Castillejea raupii Pennell	Raup's Paintbrush
Pedicularis labridorica Wirsing	Labrador Lousewort
Lentibularicaceae	
Pinquicula villosa L.	Common Butterwort
Utricularia minor L	Small Bladderwort
Utricularia vulgaris L.	Common Bladderwort
Rubiaceae	
Galium boreale L.	Northern Bedstraw
Galium labridoricum Wieg.	Labrador Bedstraw
Caprifoliaceae	
Linnaea borealis L.	Twin-flower
Viburnum edule (Michx.) Raf.	Low Bush Cranberry
Campanulaceae	
Campanula rotundifolia L.	Harebell
Compositae	
Achillea millefolium L.	Common Yarrow
Achillea sibirica Ledeb.	Northern Yarrow
Antennaria neglecta Greene	Spotted Everlasting or Pussytoes
Antennaria rosea Greene	Rosy Evrlasting or Pussytoes
Hieracium umbellatum L.	Narrow-leaved Hawkweed
Petasites palmatus (Ait.) A. Gray	Palmate-leaved Coltsfoot
Petasites sagittatus (Pursh) A. Gray	Arrow-leaved Coltsfoot
Senecio streptanthifolius Greene	Northern Ragwort
Solidago spathulata DC.	Mountain Goldenrod
Taraxacum officinale Weber	Common Dandelion

APPENDIX 2. BIOGEOGRAPHY OF THE BISTCHO LAKE NON-VASCULAR FLORA

Species	Distribution
Mosses[1]	
Aulacomnium palustre	Circumboreal
Brachythecium salebrosum	Circumboreal
Bryum pseudotriquetrum	Circumboreal
Dicranum elongatum	Circumboreal
Dicranum fuscescens	Circumboreal
Dicranum undulatum	Circumboreal
Drepanocladus uncinatus	Circumboreal
Fontinalis hypnoides	Circumboreal
Hylocomium splendens	Circumboreal
Oncophorus wahlenbergii	Circumboreal
Plagiomnium ellipticum	Circumboreal
Pleurozium schreberi	Circumboreal
Pohlia nutans	Circumboreal
Polytrichum juniperinum	Circumboreal
Polytrichum piliferum	Circumboreal
Ptilium crista-castrensis	Circumboreal
Sphagnum fimbriatum	Circumboreal
Sphagnum fuscum	Circumboreal
Sphagnum nemoreum	Circumboreal
Sphagnum squarrosum	Circumboreal
Tomenthypnum nitens	Circumboreal
Hepatics[1]	
Marchantia polymorpha	
Mylia anomala	
Ptilidium ciliare	
Lichens[2]	
Bryoria sp.	-
Cetraria ciliatis	?
Cetraria ericetorum	Circumpolar Arctic-Alpine-Boreal
Cetraria halei	Circumpolar Low Arctic-Boreal
Cetraria nivalis	Circumpolar Arctic-Alpine-Boreal
Cetraria pinastri	Circumpolar Low Arctic-Boreal
Cladina arbuscula	Circumpolar Low Arctic-Boreal
Cladina mitis	Circumpolar Low Arctic-Boreal
Cladina rangiferina	Circumpolar Low Arctic-Boreal
Cladina stellaris	Circumpolar Arctic-Alpine-Boreal
Cladonia amaurocraea	Circumpolar Low Arctic-Boreal
Cladonia coccifera	Circumpolar Low Arctic-Boreal
Cladonia cornuta	Circumpolar Low Arctic-Boreal
Cladonia deformis	Circumpolar Low Arctic-Boreal
Cladonia fimbriata	Circumpolar Low Arctic-Boreal
Cladonia gracilis	Circumpolar Arctic-Alpine-Boreal
Cladonia phyllophora	Circumpolar-Arctic-Alpine-Boreal

cont.

APPENDIX 2. cont.

Species	Distribution
Cladonia sulphurina	Circumpolar Low Arctic-Boreal
Cladonia uncialis	Circumpolar Arctic-Alpine-Boreal
Evernia sp.	-
Evernia mesomorpha	Circumboreal
Hypogymnia physodes	Circumpolar Arctic-Alpine-Boreal
Icmadophilia ericetorum	Circumboreal
nephroma arctica	Circumpolar Arctic-Alpine-Boreal
Parmelia sulcata	Circumpolar Low Arctic-Boreal
Parmeliopsis ambigua	Circumpolar Low Arctic-Boreal
Peltigera canina	Circumpolar Low Arctic-Boreal
Peltigera malacea	Circumpolar Low Arctic-Boreal
Peltigera polydactyla	Circumpolar Low Arctic-Boreal
Stereocaulon alpinum	Circumpolar Arctic-Alpine
Usnea sp.	-

1. Moss and hepatic distributions are from Schofield (1969).
2. Lichen distributions are from Bird and Marsh (1972, 1973) and Thomson (1984).

Wide-Ranging Forest Species/Tundra/Pacific Coast Alaska to Washington

Equisetum scirpoides Michx.
Elymus innovatus Beal
Carex gynocrates Wormsk.
Juncus balticus Willd.
Corallorhiza trifida Chatelain
Habenaria obtusata (Pursh) Richards
Parnassia palustris L.
Potentilla palustris (L.) Scop.
Rubus chamaemorus L.
Empetrum nigrum L.
Epilobium angustifolium L. ssp. *angustifolium*
Myriophylum exalbescens Fern.
Orthilia secunda (L.) House
Ledum groenlandicum Oeder.
Oxycoccus microcarpus Turcz.
Campanula rotundifolia L.

Wide-Ranging Forest Species/Tundra/Continental

Carex vaginata Tausch
Stellaria longipes Goldie
Ranunculus gmelinii DC.
Potentilla fruticosa L.
Astragalus eucosmus Robins.
Vaccinium vitis-idaea L.
Petasites sagittatus (Pursh.) A. Gray

Wide-Ranging Forest Species/Boreal Forest/Pacific Coast

Lycopodium annotinum L.
Equisetum fluviatile L.
Equisetum hyemale L.
Potamogeton richardsonii (Benn.) Rydb.
Smilacina stellata (L.) Desf.
Poa pratensis L.
Carex brunnescens (Pers.) Poir
Carex disperma Dewey
Carex rostrata Stokes
Spiranthes romanzoffiana Cham. & Schlect.
Salix bebbiana Sarg.
Urtica dioica L. ssp. *gracilis* (Ait.) Selander
Cerastium arvense L.
Actaea rubra L.
Ribes triste Pall.
Potentilla norvegica L.
Rubus idaeus L.
Shepherdia canadensis (L.) Nutt.
Cornus canadensis L.
Cornus stolonifera Michx.
Moneses uniflora (L.) A. Gray
Pyrola asarifolia Michx.
Pyrola chlorantha Sw.
Arctostaphylos uva-ursi (L.) Spreng.
Uticularia minor L.
Uticularia vulgaris L.
Galium boreale L.
Linnaea vorealis L.
Viburnum edule (Michx.) Raf.
Taraxacum officinale Weber

Wide-Ranging Forest Species/Boreal Forest/Coastal Alaska

Lycopodium complanatum L.
Lycopodium clavatum L.
Equisetum pratense Ehrh.
Equisetum sylvaticum L.
Botrychium lunaria (L.) Sw.
Populus balsamifera L.
Populus tremuloides Michx.
Geocaulon lividum (Richards.) Fern.
Stellaria longifolia Muhl.
Ribes hudsonianum Richards.
Rosa acicularis Lindl.
Antennaria rosea Greene

Wide-Ranging Forest Species/Boreal Forest/Coastal B.C. and Washington

Carex aureae Nutt.
Carex siccata Dewey
Calypso bulbosa (L.) Oakes
Geum macrophyllum Willd.
ssp. perincisum (Rydb.) Hult.
Lathyrus ochroleucus Hook.
Oxytropis deflexa (Pall.) DC.
var. *sericea* T. & G.
Vicia americana Muhl.
Geranium bicknellia Britt.
Sium suave L.
Scutellaria galericulata L.
Galium labradoricum L.
Achillea millefolium L.

cont.

Wide-Ranging Forest Species/Boreal Forest/Continental

Larix laricina (Du Roi) K. Koch
Picea glauca (Moench) Voss
Picea mariana (Mill.) BSP.
Pinus banksiana Lamb.
Festuca saximontana Rydb.
Oryzopsis pungens (Torr.) A.S. Hitchc.
Carex aenea Fern.
Carex concinna R.Br.
Goodyera repens (L.) R.Br.
Orchis rotundifolia Banks ex. Pursh
Salix myrtillifolia Anderss.
Alnus tenuifolia Nutt.
Betula papyrifera Marsh
var. subcordata (Rydb.) Sarg.
Betula pumila L.
Chenopodium capitatum (L.) Aschers.
Nuphar variegatum Engelm.
Thalictrum venulosum Trel.
Corydalis aurea Willd.
Mitella nuda L.
Ribes glandulosum Grauer
Ribes oxycanthoides L.
Amelanchier alnifolia Medic.
Potentilla pennsylvanica L.
Rubus arcticus L.
Rubus pubescens Raf.
Astragalus americanus (Hook.) M.E. Jones
Viola renifolia A. Gray
Cicuta maculata L.
Chamaedaphne calyculata (L.) Moench
Trientalis borealis L.
Phacelia franklinii (R.Br.) A. Gray
Mertensia paniculata (Ait.) G. Don.
Dracocephalum parviflorum Nutt.
Achillea sibirica Ledeb.
Antennaria neglecta Greene
Hieracium umbellatum L.
Petasites palmatus (Ait.) A. Gray
Solidago spathulata DC.

Wide-Ranging Arctic-Alpine/Boreal/Pacific Coast Mtns. of Alaska & Panhandle

Poa interior Rydb.
Carex capillaris L.
Chrysosplenium tetrandrum (Lund) T. Fries
Vaccinium uliginosum L.
Androsace septentrionalis L.

Wide-Ranging Arctic-Alpine/Boreal Forest/Continental

Calamagrostis purpurascens R.Br. *purpurascens*

Wide-Ranging Subarctic-Subalpine/Pacific Coast of Alaska & Panhandle

Potamogeton alpinus Balbis
Calamagrostis canadensis (Michx.) Beauv.
ssp. *langsdorfii* (Link) Hult.
Luzula multiflora (Retz.) Lej.
Luzula parviflora (Ehrh.) Desv.
Draba aurea Vahl.
Andromeda polifolia L.
Ledum palustre L.
Pedicularis labradorica Wirsing
Pinquicula villosa L.

Wide-Ranging Subarctic-Subalpine/Continental

Carex capitata L.
Eriophorum vaginatum L.
Salix glauca L.
Arctostaphylos rubra (Rehder & Wils.) Fern.
Castillejea raupii Pennell

Alaskan-Cordilleran/Pacific Coast of Alaska & Panhandle/Continental

Arctagrostis arundinacea (Trin.) Beal

Cordilleran/Continental

Carex atrosquama Mack.
Fragaria virginiana Duchesne
Senecio streptanthifolius Greene

cont.

Grassland/Parkland
Arabis glabra (L.) Bernh.

Cosmpolitan

Equisetum arvense L.	*Hippuris vulgaris* L.
Carex aquatilis Wahlenb.	

PEATLAND HYMENOPTERA OF BISTCHO LAKE, ALBERTA: A FAUNAL COMPARISON OF A SUBARCTIC PEATLAND TO A MID-BOREAL CONTINENTAL PEATLAND IN ALBERTA

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The Invertebrate Zoology Program at the Provincial Museum of Alberta is involved with the acquisition of insects and other invertebrate fauna in order to document the distribution, taxonomy, systematics, diversity and biogeographic relationships of our fauna. Our participation in the expedition to Bistcho Lake (Fig. 1) was aimed at providing the first comprehensive arthropod samples from the area, thus acquiring the collection resources necessary to help carry out our mandate. Secondly, part of the sampling program at Bistcho Lake was designed to obtain collections of subarctic peatland fauna to act as comparative samples in a more extensive study of the arthropod fauna of a mid-boreal continental peatland habitat near Edmonton (Wagner Bog, Fig. 2). The following is an account of this expedition and will review collection techniques, introduce the peatlands habitat, sampling protocol, and present partial results of our comparative peatlands study with respect to Hymenoptera (ants, wasps, and bees). Annotated checklists or faunal overviews are presented for the Hymenoptera, Coleoptera (beetles), the Diptera (flies) and the Lepidoptera (butterflies and moths).

INTRODUCTION

The Hymenoptera are among the largest groups of insects with over 100,000 named species representing less than 30% of the fauna likely to exist. The majority of wasps are parasitoids, attacking eggs, larval, nymphal or pupal stages of other insects and spiders. Unlike parasites where many individuals can feed from a single host without killing it (i.e., mosquitos feeding on man), parasitoids attack a single host, develop on or in it, and invariably kill it. This ability to attack other insects and kill them has been exploited in numerous biological control programs where wasps have been released as control agents. Other groups of wasps are predatory on insects and spiders, the bees are pollinators, only the sawflies are herbivores, a few of them serious pests.

AN INTRODUCTION TO PEATLANDS

The Invertebrate Program at the Provincial Museum has, for the past few years, been involved in the study of the terrestrial insect fauna associated with peatlands. Studies were conducted on a mixed peatland at Wagner Natural Area, 8 km west of Edmonton. Initial results indicate a rich invertebrate fauna of 4,000 to 6,000 species. The Bistcho Lake expedition provided an opportunity to obtain peatland samples from a boreal subarctic biome. These samples can now be compared to those from our mixed peatland.

Wetlands are those areas that are neither fully terrestrial nor fully aquatic; they occupy about 170,000,000 ha, or 18% of Canada's land surface (Zoltai and Pollett 1983). According to Zoltai (1987) wetlands are areas where wet soils are prevalent, the water table is near or above the mineral soil for most of the growing season and the prevalent vegetation is adapted to wet environments. Peatlands occupy the largest area of wetlands in Canada, yet their insect fauna is poorly known in comparison to that of the much less abundant marshes (Rosenberg and Danks 1987). Peatlands are areas where hydrophilic vegetation remains have accumulated over time to depths greater than 40 cm. They form in areas of imperfect drainage with both mineral soil and lower peat layers in a constant waterlogged condition. Zoltai and Pollett (1983) estimated that peatlands occupy approximately 12% of the land area of Canada.

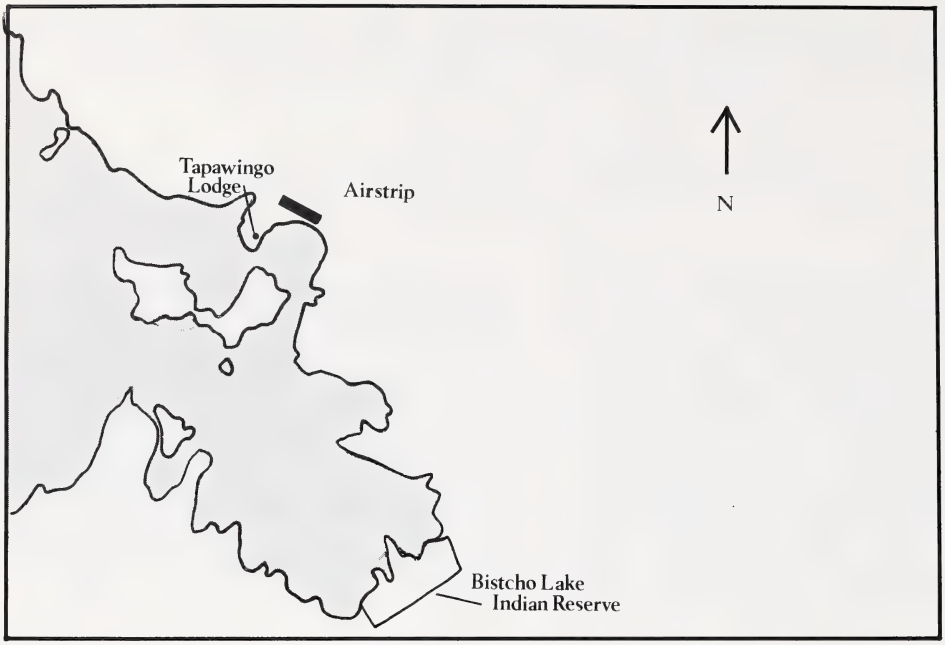

Figure 1. The study area on the east shore of Bistcho Lake.

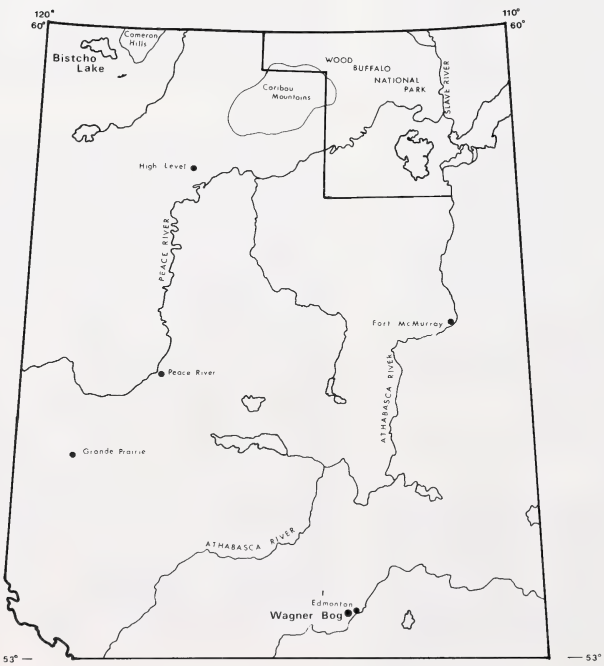

Figure 2. Location of the Bistcho Lake and Wagner bog study areas in Alberta.

Peatlands can be divided into fens and bogs based on vegetation and pH. Zoltai (1987) described bogs as peat-covered wetlands where the vegetation shows the effects of a high water table and a general lack of nutrients. The water is acidic, with a pH less than 4.5. In bogs cushion-forming *Sphagnum* mosses are common, along with ericaceous shrubs, and *Picea mariana.* Zoltai (1987) described fens as waterlogged peatlands but the water is generally rich in mineral nutrients. The water is circumneutral (pH 5.5 - 7.5), although in nutrient poor areas it may be more acid. The vegetation consists of grasses, sedges, brown mosses and shrubs in various proportions, and some fens may also sustain trees.

In areas of high rainfall, such as coastal situations, *Sphagnum* growth can be rapid and large amounts of peat can accumulate over a short period of time. In these situations, the accumulation of peat serves to isolate the mineral soil from the vegetation so that nutrients are available only from rainfall and airborne drift. Additionally, *Sphagnum* has the ability to acidify the surrounding environment (Vitt 1982). These conditions result in the formation of bogs. In Alberta, with its continental climate, *Sphagnum* does not develop as quickly, decomposition of plant material is more rapid, and peat buildup slower. The vegetation is in contact with mineral soil or with water relatively rich in minerals. This results in the formation of fens where the peat is largely composed of brown mosses in alkaline conditions (Vitt 1982). As peat layers slowly accumulate, acidic *Sphagnum* hummocks begin to dominate the fen and a gradual succession to bog conditions begins.

STUDY AREAS

The Wagner Natural Area, a peatland located 8 km west of Edmonton, formed as a result of Pleistocene glaciation. Melting glacial ice left deposits of sand and gravel which today form the main aquifer in the area, allowing ground water to flow several km downhill to the Wagner Natural Area. The Wagner Natural Area lies below the piezometric surface and is characterized by numerous springs which have a year round water temperature of about 40^{o} C (Prosser 1982). A major component of water in these springs is calcium carbonate, which typically occurs in the glacial deposits of the area. When water reaches the surface through these springs the calcium carbonate precipitates as a white paste or ooze called marl. Over time these have formed the large marl flats characteristic of the Wagner Natural Area. Cores taken from Wagner show peat accumulations of 157 cm in *Picea mariana* dominated areas and 236 cm in areas near open water (Johnson 1982). Based on these samples Johnson (1982) estimated the age of the peatland at 4,700 years.

The peatland in the Wagner Natural Area is a complex of pools, marl flats, carpets of brown moss, and plants characteristic of alkaline fens. These give way to hummocks of *Sphagnum* and other acid tolerant plants, especially *Picea mariana* and those shrubs characteristic of nutrient poor bogs. The resulting mosaic of habitats gives the Wagner Natural Area one of the more complex floras and faunas in the province. The Wagner peatland represents the beginning of a successional process that will eventually result in *Sphagnum* bog formation with acidic conditions. Because of this, any fauna collected at Wagner may have considerable value in understanding the faunal succession that may follow the ageing of these peatlands.

Collections from the Bistcho Lake bog formation will be used to provide some comparison to what initial results indicate is a highly species rich peatland habitat at Wagner. The Wagner site lies in an area which Zoltai and Pollett (1983) classed as continental, mid-boreal wetland with 5-25% of the surface considered wetlands. The Bistcho Lake site, 750 km northwest of Wagner, is classed by Zoltai (1987) as subarctic wetland with 75-100% of the surface considered wetland (Zoltai and Pollett 1983). In terms of percentage of total land surface expressed as wetlands, Bistcho Lake and the surrounding area into British Columbia and the Northwest Territories is the second largest area of Canada with this high a percentage of wetlands. The vast Hudson Bay lowlands is the largest area with up to 100% of the surface considered wetlands. In addition, the Bistcho Lake bog formation is not mixed but rather is characterized by open *Picea mariana/Ledum/Sphagnum-Cladina* typical of boreal forest bog formations and has permafrost (?) at 52 cm, typical of subarctic wetlands. More detailed descriptions of the habitat are provided in Hastings and Ellis (this volume).

COLLECTING TECHNIQUES

The Hymenoptera, with one or two known exceptions, are not aquatic and are not collected with sampling devices designed for aquatic fauna. They do, however, attack aquatic fauna and can be abundant in wet habitats. The following techniques reflect the terrestrial nature of the hymenoptera, they are

designed to sample fauna from soil, litter, ground level, low vegetation and aerial habitats.

SWEEPING: This is among the most flexible of the collecting techniques and one of the oldest. Sweep samples are obtained using a standard butterfly net with a micro-mesh net bag rather than the coarse mesh used for Lepidoptera. The coarse mesh nets allow fauna under 3 mm to walk or even fly through the mesh. Since 90% of some faunas can be under 3 mm, only a small fraction of the existing species can be sampled by sweeping with coarse nets. The fine or micro-mesh nets are capable of collecting the smallest of insects some of which are in the range of 0.1 mm.

Sweeping allows a collector to sample a particular habitat rapidly. It is a quick, highly portable and efficient method which provides a relatively large sample. However, sweeping captures only free-living insects and consequently is ineffective in sampling those species residing in cryptic habitats like leaves, stems, wood, or soil. In addition, sweep samples almost always contain large amounts of plant debris resulting in samples that are difficult to work with. The latter problem can be solved with the use of a photo-sorter, a mechanism which uses the phototactic response of an insect to sort living specimens from plant debris. A well designed photo-sorter will provide both a positively and negatively phototactic sample if a sweep sample is placed in its chamber immediately after collection.

PAN TRAPS: This is probably the best method for long-term sampling of ground dwelling fauna. Although a number of variations exist with respect to trap design, the Bistcho Lake pan trap consisted of an aluminum baking pan painted canary yellow. The yellow coloring is attractive to a number of insect groups. Pan traps are sunk into the substrate until the top lip is level with the surface of the substrate. Water is added to the pan until it is two thirds full. A drop of soap is added as a surfactant (which destroys surface tension of the water) since most insects can use the surface film to crawl or swim the short distance across the pan. The addition of a surfactant and the resulting loss of surface tension causes the insects to sink and drown. Pan traps are best serviced once a day to obtain specimens of maximum quality. Should longer periods be necessary the water can be supersaturated with salt which acts as a preservative and prevents destruction of the sample from osmotic pressures rupturing the specimens.

Insects are removed from the pan trap using an aquarium dip net of a mesh size designed for handling very small tropical fish eggs. As is the case with the sweep sample most of the fauna in a pan trap is under 3 mm in size, much of it composed of minute wingless parasitoids that attack eggs of other insects at ground level, in the soil, or in associated debris. Without a mesh of appropriate size, most of this micro fraction will be left in the pan trap and begin to decompose. Active cultures of fungi then become established hastening the rate of decomposition of new specimens. A total of 19 pan traps were placed at Bistcho Lake, 12 in a peatland bog habitat. Pan traps yield high numbers of active insects associated with the soil, litter or ground level habitats. They are not effective in capturing species in cryptic habitats unless those species move from one habitat to another.

MALAISE TRAPS: These traps are named for their architect, Rene Malaise (Malaise 1937), and are designed to sample flying insects in low aerial habitats like bushes. This is, without doubt, the most effective method of passively sampling terrestrial insects. A well-positioned trap can yield as many as 60,000 specimens per day.

Malaise traps resemble a rectangular tent, with one end higher than the other, and the long walls removed and placed along the middle. The trap works by using the insects phototactic response and also the tendency for most insects to walk or fly upward when confronted by a barrier. The trap is black on the bottom, white on the roof and constructed with a double interlocking woven polyester. Once again the mesh is very fine. Although a solid barrier would be more efficient, wind resistance is a factor in traps of this design, a fine mesh allows wind to pass through but retains small specimens. As these traps are expensive to construct particular attention should be paid to materials used. For instance, nylon, a readily available fabric, is photodegradable and will rot by the end of a collecting season meaning the loss of a $250.00 investment in a single trap. Of the artificial fibers, only polyester will not decompose on exposure to light and, barring unforseen wear, will last for years under field conditions. Double interlocking weave is also necessary to prevent the mesh from separating when it is stretched. Most mesh type fabrics are a single interlocking weave and can be separated either in one direction or another.

Insects fly into the open sides of the Malaise trap and strike the middle wall from where they walk or

fly upward. The sloping roof of the trap prevents the insects from flying out of the trap (without first flying downward) and funnels the insects toward the peak of the roof. The roof is colored white to reinforce the upward movement of specimens with a positive phototactic response. Since one end of the trap is lower than the other, specimens eventually concentrate at the highest point in the peak of the roof from where a walk or fly-through tube leads to a collecting head. The collecting head is a bottle partially filled with water and a drop of soap, the same combination used in pan traps in the previous section. The bottle can be detached to obtain the specimens.

Although Malaise traps can be placed in just about any habitat, they were designed for low bushes and hedgerows, consequently best results are obtained in these habitats. Precise placement of the trap requires some experience since fly-ways and funnelling effects of certain hedgerow configurations can vastly increase the collecting potential of these traps. Malaise traps are particularly effective in capturing active insects, in this case in open habitats with low vegetation. Insects that occupy cryptic habitats or do not fly are rarely collected. A recent modification of the Malaise is the flight-intercept trap, similar in basic construction but of less complex design. Masner and Goulet (1981) presented a design and operating instructions for the flight-intercept type of trap.

SIFTING: This is a method by which insects in litter, the humic layer of soils, decaying wood, or plants can be concentrated and either selectively or totally removed from the debris. A sifter consists of a 1.0 to 1.3 m (3 to 4 feet) tube of rip-stop nylon with a draw string tying the lower end and a sieve incorporated about 30 cm (1 foot) from the top end. A sample of debris is placed in the top chamber and gently sieved with a motion that slowly rotates the sample. The finer particulate matter and most insects will pass through the sieve and collect in the tied off lower section. The remains in the top chamber are discarded and six or more samples of the same type of debris are sifted to produce a larger mass of concentrated insect/debris material in the lower section of the sifter. The contents of this section can then either be placed gradually in a white pan and individual insects selectively removed or the whole concentrated insect/debris mass can be placed in a Berlese funnel and the entire fauna extracted. Sifting is a technique favored by beetle and mite collectors because it provides high mobility, large samples and quick results in habitats that are often otherwise difficult to sample. Many species collected by sifting will not be collected by pan traps in the same habitat since some species rarely go to the soil or litter surface and others avoid disturbed areas.

BERLESE FUNNEL: This funnel is named for its designer, Antonio Berlese. Modifications of his design are the most practical method of extracting insects and mites from the sifted samples mentioned previously as well as bark, rotting wood, fungi, mosses, plant parts, manure, freshly killed animals, nests of birds, mammals and social insects. The funnel has two chambers separated by a sieve and a baffle. The sample is placed in the upper chamber and, in our case, exposed to a 60 watt light source powered by a portable generator. Heat from the light bulb drives insects in the sample down through the sieve where they are temporarily stopped by the baffle. The baffle prevents soil or debris from contaminating the final sample. The insects and mites eventually walk through the baffle and fall or walk down the funnel to the collection chamber, a plastic bag containing water and a drop of soap. A number of trap designs are available, some of them collapsible. Martin (1977) reviewed the basic design and operation of the Berlese funnel.

FIELD SPECIMEN STORAGE AND HANDLING: In all the above techniques specimens are killed in a solution of soap and water. The soap not only acts as a surfactant but cleans the specimens, thus facilitating identification. Specimens are left no more than 24 hours before they are transferred to plastic whirl-pacs in a 70% solution of alcohol. The use of whirl-pacs eliminates the bulky storage jars that use more alcohol and are subject to breakage and loss of specimens when transported. Storage jars are used in the lab to hold specimens before further processing. Manipulation of specimens is accomplished by means of an aquarium dip net mentioned in the section on pan traps.

SAMPLING PROTOCOL

As all known techniques sample only a fraction of the species, it is important to use a combination of techniques and to record sampling protocol and habitat in detail for comparison to other studies. Spot collections and short term samples are not particularly useful because seasons can vary considerably from year to year and the insect fauna undergoes substantial change over the season. Because of faunal succession over a season and the variability of the season itself, the most ecologically significant collections are obtained by sampling for the duration of ac-

tivity throughout the season (Finnamore 1988). This can include mid-winter in some Canadian habitats.

The primary method of specimen collection in both Wagner and Bistcho was the pan trap because of its ability to collect samples heavily dominated by species most likely to be permanent peatland residents. These collections were supplemented with Malaise trap samples, sweep samples and Berlese funnel extractions. The latter was not employed at Wagner because the technology was unavailable to the program at that time. At Wagner nine peatland habitats were selected on the basis of an *a priori* habitat classification. Each habitat received a triple replicate of pan traps except a hedgerow site which received a Malaise trap. Traps were sampled at regular intervals and date of capture and trap number were recorded for each sample. Specimens were then sorted to Ordinal level and the Coleoptera received priority for identification.

Once species level determinations were available for the Coleoptera, the *a priori* habitat classification system was tested by performing a cluster analysis, based on the presence or absence of beetle species from each trap site. This analysis calculated a similarity matrix between all trap sites and presented the outcome in the form of a dendrogram. Trap sites were clustered using an average distance algorithm, based on Jaccard's coefficient of similarity. The analysis was based on 5,232 specimens in 335 species at nine trap locations.

The result of this analysis was that the classification of 9 *a priori* sites was reduced to 4 distinct habitats. These were: (1) open marl flats, (2) Black Spruce forest, (3) sedge and shrub areas, and (4) aerial hedgerow. From this analysis we were able to decrease the redundancy in sampling inherent in the *a priori* classification in our survey of the Bistcho Lake site. The sites selected at Bistcho correspond roughly to the habitat classification we obtained from the Wagner analysis of habitats, which reflected vegetation cover. Four sites were selected: (1) shoreline and open lichens without shrubs, (2) shrubs, (3) higher bushes - open hedgerow, and (4) open forest. Each site received triple replications of pan traps except site 3 in which a Malaise trap was used. The traps were serviced every day and date and trap number were recorded for each sample. In addition peat samples were collected and placed in Berlese funnels to extract the insect and mite faunas. Sweep samples from the bog were also obtained to supplement these collections.

A comparison of trap collecting vs spot collecting (hunt and capture individual specimens) was conducted for a single group to assess the efficiency of the trap techniques. The results are presented in the Annotated Checklist Of Carabid Beetles (Shpeley, this volume).

A checklist of the hymenoptera from the peatlands of Bistcho Lake is provided in Table 1. This list of species is intended to supplement and act as a reference to the annotated species list which follows.

ANNOTATED CHECKLIST OF PEATLAND HYMENOPTERA FROM BISTCHO LAKE

Family Anthophoridae

Perhaps the largest family of bees, they are exceptionally well represented in the New World by numerous species and are likely the largest and most diverse assemblage of these bees in the world.

ANTHOPHORINAE: a large group of both pollen-collecting and cleptoparasitic bees.

<u>Anthophora</u>: these pollen-collecting, ground nesting bees are represented in the Nearctic fauna by 63 species. Only 6 species occur in Canada. One is found in the east of the country but all 6 species occur in the west. The collection from Bistcho Lake represents the northernmost distribution record for the genus. There are no keys to all the species in the genus but Timberlake (1951) keyed the species in the western United States and Brooks (1983) provided keys to the species groups of the subgenus *Anthophora* in the New World.

1. **<u>Anthophora</u> (<u>Anthophora</u>) <u>urbana</u> <u>urbana</u> Cresson.** 1 male.

Distribution. CANADA: Alberta. This specimen represents the first record in Canada for this species, it was also collected at the Wagner site near Edmonton. USA: Idaho, Washington, Colorado, Utah, New Mexico, Arizona, California. MEXICO: Baja California, Sonora.

Predators/parasitoids. DIPTERA: CONOPIDAE: *Zodion obliquefasciatum* (Macquaert). These flies are internal parasitoids of aculeate Hymenoptera which ovipositing females attack in flight (McAlpine *et al. 1987). COLEOPTERA: MELOIDAE: Meloe niger* Kirby. The larvae of these blister beetles under-

Table 1. Checklist of peatland hymenoptera from Bistcho Lake.

ANTHOPHORIDAE
1. *Anthophora* (*Anthophora*) *urbana urbana* Cresson
LARRIDAE
2. *Trypoxylon aldrichi* Sandhouse
VESPIDAE
3. *Vespula* (*Dolichovespula*) *arctica* Rohwer
4. *Vespula* (*Dolichovespula*) *arenaria* (Fabricius)
5. *Vespula* (*Dolichovespula*) *norvegicoides* (Sladen)
FORMICIDAE
6. *Myrmica incompleta incompleta* Provancher
7. *Leptothorax (Leptothorax) provancheri* Emery
8. *Camponotus (Camponotus) herculeanus* (Linnaeus)
9. *Formica argentea* Wheeler
10. *Formica subnuda* Emery
DRYINIDAE
11. Gonatopodinae sp.
CHRYSIDIDAE
12. *Chrysis coerulans* Fabricius
FIGITIDAE
13. *Melanips* sp.
EUCOILIDAE
14. *Kleidotoma* (*Tetrarhoptra*) sp. A
CHARIPIDAE
15. *Alloxysta bicolor* (Baker)
16. *Alloxysta commensuratus* Andrews
17. *Alloxysta vandenboschi* Andrews
18. *Alloxysta victrix* (Westwood)
ICHNEUMONIDAE: PIMPLINAE
19. *Dolichomitus sericeus* (Hartig)
20. *Tromatobia ovivora* (Boheman)
21. *Zaglyptus varipes incompletus* (Cresson)
22. *Itoplectis quadricingulata* (Provancher)
23. *Itoplectis vesca* Townes
24. *Ephialtes ontario* (Cresson)
25. *Ephialtes picticornis* (Cresson)
26. *Delomerista gelida* Walkley
27. *Delomerista novita* (Cresson)
28. *Pseudorhyssa maculicoxis* (Kriechbaumer)
29. *Rhyssa pursuasoria pursuasoria* (Linnaeus)
:TRYPHONINAE
30. *Phytodietus* (*Phytodietus*) sp.
31. *Polyblastus* (*Labroctonus*) *buccatus* Townes
32. *Polyblastus* (*Labroctonus*) *stenocentrus* Holmgren
33. *Ctenochira pectoralis* Townes
34. *Erromenus caelator* Townes
35. *Erromenus punctulatus* Holmgren
36. *Monoblastus proximus* Townes
37. *Eridolius* sp. A
38. *Eridolius* sp. B
39. *Eridolius* sp. F
:ADELOGNATHINAE
40. *Adelognathus* sp. E
41. *Adelognathus* sp. G
:BANCHINAE
42. *Glypta* sp.
43. *Lissonota amphithyris* Townes
44. *Lissonota clypeator vivida* Cresson
45. *Lissonota uncata* Townes
46. *Exetastes* sp. A
47. *Exetastes* sp. B
:CTENOPELMATINAE
48. *Ctenopelma* sp. F
49. *Xenoschesis* sp. D
50. *Trematopygus semirufus* (Cresson)

cont.

go hypermetamorphosis with different larval instars exhibiting different appearances. The first instar is the active larval form called a triungulin. The triungulin waits on a flower for a bee and is carried by the bee back to the nest whereupon the eggs of the bee are attacked HYMENOPTERA: ANTHOPHORIDAE: *Xeromelecta californica* (Cresson). This bee is a cleptoparasite (parasite larva consumes the food supplied for the host larva) in the nests of Anthophora urbana.

Trophic level. Pollinator. This highly polylectic species has been recorded from 164 species of flowering plants (Krombein *et al.* 1979).

Family Larridae

The Larridae with 3,300 described species is a moderately large family found around the world. Both subfamilies, Larrinae and Crabroninae are found in Canada. The Larrinae contain two thirds of the world fauna but in southern Canada represent only one third of our fauna (38 species). The Cra-

Table 1. cont.

:CTENOPELMATINAE cont.	79. *Enizemum tridentatum* Dasch
51. *Himerta* sp. D	80. *Syrphophilus tricinctorius* (Thunberg)
52. *Campodorus* sp. C	81. *Diplazon algidus* Dasch
53. *Campodorus* sp. E	82. *Sussaba cognata faceta* Dasch
54. *Campodorus* sp. L	83. *Sussaba placita* Dasch
55. *Campodorus* sp. M	84. *Sussaba punctiventris* (Thomson)
:PORIZONTINAE	:OXYTORINAE
56. *Bathyplectes* sp. L	85. *Hyperacmus* sp.
57. *Bathyplectes* sp. N	86. *Entypoma* sp.
58. *Synetaeris* sp. B	87. *Pantisarthrus* sp. A
59. *Dusona glauca caliginosa* (Walley)	88. *Proclitus* sp. A
60. *Dusona luctuosa* (Provancher)	89. *Blapticus* sp. D
61. *Dusona vara* (Walley)	90. *Eusterinx* sp. E
62. *Dolophron* sp. A	:ORTHOCENTRINAE
63. *Phobocampe* sp. A	91. *Orthocentrus* sp. A
64. *Phobocampe* sp. C	92. *Orthocentrus* sp. B
65. *Phobocampe* sp. E	93. *Stenomacrus* sp.
66. *Phobocampe* sp. F	PAMPHILIIDAE
67. *Tranosema* sp.	94. *Pamphilius ochreipes* (Cresson)
68. *Diadegma* sp. C	TENTHREDINIDAE
69. *Diadegma* sp. O	95. *Priophorus pallipes* (Lepeletier)
70. *Diadegma* sp. P	96. *Pikonema alaskensis* (Rohwer)
71. *Hyposoter* sp. A	97. *Pristophora* sp. A
72. *Olesicampe* sp. A	98. *Pristophora* sp. B
73. *Olesicampe* sp. B	99. *Pristophora* sp. C
:MESOCHORINAE	100. *Croesus latitarsus* Norton
74. *Astiphromma luculentum* Dasch	101. *Nematus* sp. A
75. *Mesochorus curvulus* Thomson	102. *Nematus* sp. B
76. *Mesochorus dreisbachi* Dasch	103. *Phyllocolpa* sp. A
:DIPLAZONTINAE	104. *Phyllocolpa* sp. B
77. *Syrphoctonus nigritarsus fuscitarsus* (Provancher)	105. *Euura* sp.
78. *Syrphoctonus pectoralis* (Provancher)	106. *Empria ignota* (Norton)
	107. *Allantus albolabris* (Rohwer)
	108. *Pachyprotasis rapae* (Linnaeus)

bronіnae, on the other hand, occur 80 km north of the treeline and 60 species are known. Nesting behaviour in this group is variable, the Larrinae tend to be ground nesting although the Trypoxylini nest in pre-existing cavities or stems. The Crabroninae tend toward twig nests although ground nesting is not unknown.

LARRINAE: Keys to genera and biological information were provided by Bohart and Menke (1976).

Trypoxylon: species of *Trypoxylon* nest in pre-existing cavities like hollow stems or beetle borings, or construct their own mud nests. Sandhouse (1940) provided keys to the North American species. Of the 16 North American species, 7 are found in Canada.

2. **Trypoxylon aldrichi Sandhouse.** 2 males.

Distribution. CANADA: Alberta, British Columbia and north. This species was also collected at Wagner. USA: Montana, Wyoming and northern California.

Predators/parasitoids. HYMENOPTERA: PHILANTHIDAE: *Philanthus zebratus* Cresson, a predator using adults of many species of usually aculeate wasps to provision its larval cells.

Trophic level. Predator. Species of *Trypoxylon* use immature spiders to provision cells in which their larvae develop.

Family Vespidae

The Vespidae are a moderately large family, mostly tropical, although the yellow-jackets are distinctly northern in their distribution. The North American fauna has over 330 species with 62 species and possibly a further 27 occurring in Canada. These species figures do not reflect the numerous subspecies (Finnamore, unpublished).

VESPINAE: this group is distinctly northern. The 2 genera and 16 of the 18 Nearctic species are found across Canada as far north as the treeline and up to 70 km beyond it. Almost everyone is familiar with these black and yellow or black and white hornets and yellow-jackets. They are, with one or two exceptions, social, building their distinctive spherical paper nests either under ground in some species or above ground suspended from a branch or an object in other species. Most species are predators on a wide variety of insects but at least two species in our fauna are cleptoparasitic on other vespid wasps and have no worker caste. Colonies in Canada are annual, only the fertile young queens overwintering to start a new nest the following spring.

Vespula: biological information and keys to most species can be obtained from (Miller 1961 and Akre *et al.* 1981).

3. **Vespula (Dolichovespula) arctica Rohwer**. 1 female.

Distribution. CANADA: Newfoundland to Yukon. This species was also collected at Wagner. USA: Canadian zone.

Predators/parasitoids. Unknown.

Trophic level. Cleptoparasitoid. This species is an obligate parasite on colonies of *Vespula arenaria* (*Fabricius*). The adult *V. arctica* enters the nest of *V. arenaria*, destroys the queen and lays her own eggs which are raised by the host workers. No worker caste is produced (Miller 1961).

4. **Vespula (Dolichovespula) arenaria (Fabricius).** 2 females

Distribution. CANADA: Newfoundland to Yukon. This species was collected at Wagner. USA: Alaska and transcontinental in Canadian and Transition zones.

Predators/parasitoids. HYMENOPTERA: VESPIDAE: *Vespula* (*Dolichovespula*) *arctica* Rohwer (see above). ICHNEUMONIDAE: *Sphecophaga vesparum burra* (Cresson), parasitoid.

Trophic level. Predator. This species is one of the commonest wasps in North America, its nest is aerial often attached to homes where it can become a pest. In more exposed locations nests are attached to low shrubs.

5. **Vespula (Dolichovespula) norvegicoides (Sladen)**. 4 females.

Distribution. CANADA: Newfoundland to Yukon. This species was collected at Wagner. USA: transcontinental in Canadian zone and Alaska.

Predators/parasitoids. Unknown.

Trophic level. Predator. The nest is aerial usually constructed in low shrubs.

Family Formicidae

The ants are a moderately large group of over 4,600 species well-represented in North America with 586 species. Although 10 subfamilies are recognized only four of these and 111 species are found in Canada. Ants for the most part are opportunistic predators and scavengers sometimes exhibiting considerable influence on the populations of other insects. Ants are found in all parts of Canada except the arctic. Creighton (1950) treated the North American species.

MYRMICINAE: although the Myrmicinae are the largest subfamily of ants and occur around the world, they are, in North America, gradually replaced by the Formicinae as one moves northward. In Canada the Formicinae represent about 60% of the fauna (Finnamore, unpublished). There are 37 species of myrmicine ants known from Canada.

Myrmica: This genus is found as far north as Labrador and Alaska, 15 species occur in North America, 8 are found in Canada.

6. **Myrmica incompleta incompleta Provancher.** 4 workers, 2 females.

Distribution. CANADA: Labrador west to Rocky Mountains. This species was collected at Wagner. USA: south to New Jersey in the east, west to the Rocky Mountains, Colorado, Utah, New Mexico.

Predators/parasitoids. HYMENOPTERA: FORMICIDAE: *Leptothorax provancheri* Emery has been reported as an inquiline in the nests of this species.

Trophic levels. Predator. This species prefers moist grassy habitats and often nests under objects (Krombein *et al.* 1979).

Leptothorax: the North American fauna contains 33 species, 5 are found in Canada.

7. **Leptothorax (Leptothorax) provancheri Emery.** 1 worker.

Distribution. CANADA: Quebec west to Alberta. This species was collected at Wagner. USA: Maine, North Dakota, Colorado, New Mexico.

Predators/parasitoids. Unknown.

Trophic level. Inquiline. This species is a social parasite found in the nests of *Myrmica incompleta incompleta* Provancher and *M. lobicornis fracticornis* Emery.

FORMICINAE: this is the most frequently encountered subfamily of ants in Canada and in mountainous areas of the continent. There are 67 species recorded from Canada.

Camponotus: a large genus of ants some members of which are known as carpenter ants because of their habit of constructing a nest in wood but most species are soil dwellers. There are 43 species in North America of which 8 are found in Canada.

8. **Camponotus (Camponotus) herculeanus (Linnaeus).** 3 workers, 3 females, 1 male.

Distribution. CANADA: Newfoundland west to Yukon. This species was collected at Wagner. USA: Alaska south to New York, Pennsylvania, Wisconsin, Minnesota, North Dakota, Colorado, New Mexico, Utah, Oregon. EURASIA.

Predators/parasitoids. Unknown.

Trophic level. Predator. This species is probably the dominant ant in the boreal and alpine forests of North America where it forms large colonies in rotting logs and stumps usually of coniferous trees (Krombein *et al.* 1979).

Formica: the largest of the North American genera of ants. Of the 85 North American species, 40 occur in Canada. The difficult *Formica fusca* group was recently revised by Francoeur (1973).

9. **Formica argentea Wheeler.** 1 worker.

Distribution. CANADA: Quebec west to British Columbia. This species was collected at Wagner. USA: south to South Carolina, Ohio, Illinois, Iowa, South Dakota, New Mexico, Arizona, California.

Predators/parasitoids. members of this and related species are often used by slave-making species because of their docility.

Trophic level. Predator. Nests in open or semi open situations usually in sandy soil, under stones or with a low mound (Krombein *et al.* 1979).

10. **Formica subnuda Emery.** 3 workers.

Distribution. CANADA: Newfoundland west to Yukon. This species was collected at Wagner. USA: Alaska south to New York, Minnesota, North Dakota, Colorado, New Mexico, Arizona, California.

Predators/parasitoids. Unknown.

Trophic level. Cleptoparasitoid. Females of this species force their way into small host colonies and drive off the host queen and workers before raising their own brood. Only species of *Formica* are parasitized. The most likely candidates for host in the Bistcho Lake area are *Formica fusca* Linnaeus and *F. neorufibarbis* Emery. Although neither of these species was collected at Bistcho Lake, they are known to occur north to Alaska and both have previously been reported as hosts for this species.

Family Dryinidae

The Dryinidae are a small family with 844 known species. Prey are typically leafhoppers (Homoptera: Cicadellidae), the wasp larva developing as an external parasitoid protruding as a sac from the abdomen. Five of the 10 subfamilies and 38 species are known

from Canada, several species reaching the Northwest Territories. The genera and species of the world were revised by Olmi (1984).

GONATOPODINAE: the female members of this subfamily are wingless ant-like forms that in no way resemble their males.

11. **Gonatopodinae:** 1 male. Unfortunately further identification depends on characters found only in the female.

Trophic level. Parasitoid.

Family Chrysididae

The described world fauna of these bright metallic green wasps, about 3,000 species, represents 50% of the species likely to exist. The chrysidids reach their greatest diversity in the tropics with species diversity dropping sharply in northern areas like Canada. The 60 species found in Canada are for the most part distributed in the extreme south of the country although several species reach the boreal forest and sandy habitats of the Yukon. Bohart and Kimsey (1982) treated the North American species.

CHRYSIDINAE: members of this subfamily are commonly known as cuckoo-wasps because of their cleptoparasitic habits. The females lay their egg in the nest of a solitary bee (Megachilidae) or various solitary wasps before nest closure. The egg hatches, the larva seeks out and consumes the host egg then matures by consuming the food stored for the host larva.

Chrysis: of the 77 species occurring in North America, 17 are found in Canada. Members of this genus are generally cleptoparasitoids on members of the Sphecidae, Megachilidae and Eumenidae.

12. **Chrysis coerulans Fabricius.** 3 females.

Distribution. CANADA: transcontinental across southern Canada. This species was collected at Wagner. USA: transcontinental.

Predators/parasitoids. HYMENOPTERA: EULOPHIDAE: *Melittobia chalybii* Ashmead. These chalcid wasps in nature develop only in aculeate wasps and their parasites (Krombein *et al.* 1979).

Trophic level. Cleptoparasitoid. This species is known to attack a wide variety of aculeate wasps.

HYMENOPTERA: MEGACHILIDAE: *Hoplitis anthocopoides* (Schenk), a leafcutter bee; VESPIDAE: *Ancistrocerus antilope antilope* (Panzer), *A. catskill catskill* (Saussure), *A. catskill albophaleratus* (Saussure), *A. spilogaster* Cameron, *A. adiabatus adiabatus* (Saussure), *A. adiabatus cytainus* (Cameron), *A. tuberculocephalus sutterianus* (Saussure), *Euodynerus foraminatus apopkensis* (Robertson), *E. foraminatus foraminatus* (Saussure), *E. foraminatus scutellaris* (Saussure), *E. leucomelas* (Saussure), *E. megaera* (Lepeletier), *Parancistrocerus acarophorus* (Boheman), *P. salcularis rufulus* (Boheman), *Symmorphus albomarginatus* (Saussure) and *S. cristatus cristatus* (Saussure).

Family Figitidae

The Figitidae are distributed throughout the world and contain about 250 species. Of the 59 North American species 11 occur in Canada. These wasps are parasitoids on either Neuroptera (lacewings) or larval Diptera (flies). There are no keys to species for any of the Nearctic genera. Weld (1952) is still the basic reference and provides keys to the world genera.

FIGITINAE: a diverse group of wasps classified on the basis that they do not belong to either of the other two subfamilies. Of the 28 North American species, 5 are recorded from Canada. They are internal parasitoids of Diptera attacking the early larval stages but emerging from the puparium.

13. **Melanips sp.** 1 male. Further identification of this species must await a revision of the genus.

Distribution. This is the first record of this genus in Canada and probably the first record of the family in Alberta. Other species in the genus were collected at Wagner.

Trophic level. Parasitoid.

Family Eucoilidae

The largest family of the cynipoid group of wasps with about 700 described species although 10 times that number are likely to exist. Like the previous family many of the genera are poorly defined and as

a result difficult to identify. The species are parasitoids of larval Diptera and may exert some measure of population control on pests like root maggots. There are 78 species in North America but only 10 recorded from Canada although many more occur here (36 species were found at Wagner). Keys to genera were presented by Weld (1952) and Quinlan (1967) for the brachypterous (incompletely developed wings) forms.

14. Kleidotoma (Tetrarhoptra) sp. 1 female. Further identification must await a revision of the genus.

Distribution. This is the first record of the family occurring in Alberta and the first record of the subgenus in Canada. This species, although unidentified has been collected from Wagner.

Trophic level. Parasitoid.

Family Charipidae

The Charipidae are a small family of about 200 species of primary parasitoids or hyperparasitoides of Hemiptera and Homoptera. Of the 31 North American species, 16 occur in Canada. Weld (1952) provided keys to the world genera.

ALLOXYSTINAE: these wasps are hyperparasitoids of Homoptera and Hemiptera, the primary host is usually a chalcid or braconid wasp. The early stages of the hyperparasitoid are spent in the primary host usually inside an aphid but when the primary host pupates the hyperparasitoid feeds externally during its last larval instars and pupates inside the aphid skin (Ritchie, unpublished). Andrews (1978) provided keys and biological information on the Nearctic species.

15. Alloxysta bicolor **(Baker).** 1 female.

Distribution. CANADA: British Columbia. This is the first Alberta record for this species, it was also collected at Wagner. USA: Colorado.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid.

16. Alloxysta commensuratus **Andrews.** 1 male.

Distribution. CANADA: This is the first Canadian record of this species, it was also collected at Wagner. USA: Maryland.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid.

17. Alloxysta vandenboschi **Andrews.** 1 male.

Distribution. CANADA: British Columbia. This is the first Alberta record for this species. USA: Alaska.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid. HYMENOPTERA: BRACONIDAE: *Praon* sp. is the primary host in at least one reared specimen (Andrews 1978).

18. Alloxysta victrix **(Westwood).** 2 females.

Distribution. CANADA: Nova Scotia, British Columbia. This is the first Alberta record, this species was also captured at Wagner. USA: Maine, Maryland, Virginia, Wisconsin, Washington, California.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid. This species has been reported from the following primary parasitoids: HYMENOPTERA: BRACONIDAE: *Aphidius alinus* Muesebeck, *A. avenaphis* (Fitch), *A. confusus* Ashmead, *A. matricariae* Haliday, *A. nigripes* Ashmead, *A. smithi* Sharma & Subba Rao, *Praon* sp., *Trioxys* (*Trioxys*) *complanatus* Quilis. APHELINIDAE: *Aphelinus howardi* Dalla Torre.

Family Ichneumonidae

With an estimated 60,000 species the Ichneumonidae is not only the largest family of wasps but along with Curculionidae (weevils, 60,000 species) among the largest families of insects. The eastern Palaearctic and the eastern Nearctic faunas are particularly rich, with the fauna dropping off in warm, dry areas and being replaced by chalcids and braconids. Ichneumonids are mainly parasitoids on the larvae of Symphyta (Hymenoptera) and Lepidoptera but most groups of holometabolous insects (those insects which undergo complete metamorphosis, ie. egg, larva, pupa, adult) and some groups of spiders are also attacked. The type of parasitism may be ec-

toparasitic, living on the outside surface of the host, or endoparasitic, developing inside the host. The genera of Ichneumonidae were revised by Townes (1969; 1970a,b; 1971). The fauna of Canada is about 2,000 recorded species but estimates by Danks (1979) indicate our fauna may be as high as 7,000 species, a very large fraction of the estimated 8,000 species in North America.

PIMPLINAE: most species are ectoparasitoids of holometabolous larvae or pupae although some attack spider egg-sacs and spiders (Wahl, unpublished). Townes and Townes (1960) provide keys to the Nearctic species under the subfamily name Ephialtinae. Species belonging to 4 tribes were collected at Bistcho Lake; Pimplini, Echthromorphini, Delomeristini and Rhyssini.

PIMPLINI: members of this tribe are usually endoparasitoids of Lepidoptera larvae. Of the 90 North American species 61 are found in Canada.

Dolichomitus: species in this genus are parasitoids of woodborers, usually Coleoptera (Krombein *et al.* 1979).

19. **Dolichomitus sericeus (Hartig).** 1 female.

Distribution. CANADA: New Brunswick, Quebec, Ontario, Yukon, Alberta, British Columbia. This is a new record for Alberta, the species was also collected at Wagner. USA: Alaska.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. This wasp has been reported from the cerambycid beetle *Tetropium cinnamopterum* Kirby (Townes and Townes 1960).

Tromatobia: members of this genus are gregarious parasitoids of spider egg cocoons (Townes and Townes 1960).

20. **Tromatobia ovivora (Boheman).** 1 female.

Distribution. CANADA: Nova Scotia to British Columbia. This species was collected at Wagner. USA: transcontinental south of Canada, Alaska, Hawaii. MEXICO. EURASIA.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. This wasp has been reported from the following spider egg-sacs. ARANEAE: ARANEIDAE: *Araneus diadema* Linnaeus, *A. solitarius* (Emerton), *Argiope avara* Thorell, *A. argentata* (Fabricius) and *Cyrtophora californiensis* Keyserling.

Zaglyptus: members of this genus are parasitoids of spider egg cocoons and sometimes adults simultaneously (Krombein *et al.* 1979).

21. **Zaglyptus varipes incompletus (Cresson).** 1 female.

Distribution. CANADA: Nova Scotia to British Columbia. This species was collected at Wagner. USA: transcontinental south of Canada. Another subspecies occurs in Europe.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Townes and Townes (1960) reported the habitat as coarse grasses in damp places, also shrubbery, weeds and undergrowth in forest.

ECHTHROMORPHINI: species in this tribe are chiefly internal parasitoids of Lepidoptera. There are 34 species Known from North America, 28 of them are found in Canada.

Itoplectis: chiefly parasitoids on Lepidoptera but several species are hyperparasitoids on other ichneumonids (Townes and Townes 1960).

22. **Itoplectis quadricingulata (Provancher).** 1 male.

Distribution. CANADA: Newfoundland to British Columbia and Yukon. This species was collected at Wagner. USA: south to Rhode Island in the east and the mountainous states in the west. GREENLAND.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. An important parasitoid of small Lepidoptera, the following are known to be attacked: LEPIDOPTERA: PSYCHIDAE: *Hyaloscotes fragmentella* (H. Edwards); GRACILLARIIDAE: *Gracillaria* sp.; PLUTELLIDAE: *Euceratia castella* Walsingham; PYRALIDAE: *Dioryctria abietivorella* (Grote); CHOREUTIDAE: *Anthophila pariana* (Clemens); OECOPHORIDAE: *Carcina quercana* (Fabricius), *Depressaria* sp.; TORTRICIDAE: *Acleris variana* (Fernald), *Archips argyrospila* (Walker), *A. rosanus* (Linnaeus), *Choristoneura fu-*

miferana (Clemens) [spruce budworm], *C. occidentalis* Freeman, *Cnephasia longana* (Haworth), *Cydia pomonella* (Linnaeus), *Endothenia albolineana* (Kearfott), *Rhyacionia buoliana* (Denis & Schiffermuller), *R. busckana* Heinrich, *Spilonota ocellana* (Denis & Schiffermuller); PTEROPHORIDAE: *Platyptilia* sp.; GEOMETRIDAE: *Lambdina fiscellaria lugubrosa* (Hulst), *Nepytia phantasmaria* (Strecker); LASIOCAMPIDAE: *Malacosoma disstria* Hubner [tent caterpillar]; LYMANTRIIDAE: *Orgyia pseudotsugata* McDunnough. HYMENOPTERA: DIPRIONIDAE: *Neodiprion tsugae* Middleton.

23. **Itoplectis vesca Townes.** 1 female.

Distribution. CANADA: Nova Scotia, New Brunswick, Prince Edward Island, British Columbia. This is the first Alberta record for this species, it was also collected at Wagner. USA: Maine, Colorado, New Mexico, Arizona, Alaska.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Three host records are known. LEPIDOPTERA: TORTRICIDAE: *Acleris variana* (Fernald), *Choristoneura rosaceana* (Harris); COLEOPHORIDAE: *Coleophora laricella* (Hubner).

Ephialtes: species of this genus are parasitoids of lepidopterous pupae (Townes and Townes 1960).

24. **Ephialtes ontario (Cresson).** 2 males.

Distribution. CANADA: Newfoundland to British Columbia. USA: New York west to California, Alaska.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Host associations are as follows: LEPIDOPTERA: TORTRICIDAE: *Choristoneura conflicta* (Walker), *C. fumiferana* (Clemens), *C. pinus* Freeman; GEOMETRIDAE: *Lambdina fiscellaria* (Guenee), *Nepytia canosaria* (Walker).

25. **Ephialtes picticornis (Cresson).** 1 male.

Distribution. CANADA: Nova Scotia to British Columbia. This species was collected at Wagner. USA: south to North Carolina, west to California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Four hosts have been reported for this species. LEPIDOPTERA: TORTRICIDAE: *Choristoneura conflicta* (Walker), *C. rosaceana* (Harris), *Pseudosciaphila* sp., *Spilonota ocellana* (Denis & Schiffermuller).

DELOMERISTINI: most species are primary or secondary parasitoids of Lepidoptera. There are 11 North American species, 9 of them Canadian.

Delomerista: species of this genus have been raised predominently from sawflies (Hymenoptera) of the family Diprionidae (Townes and Townes 1960). In addition to the 2 species reported below there is a single male which I was unable to associate with the females of either species.

26. **Delomerista gelida Walkley.** 1 female.

Distribution. CANADA: Quebec west to British Columbia and Northwest Territories. USA: south to Pennsylvania, Colorado, Arizona, California and Alaska.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Host unknown.

27. **Delomerista novita (Cresson).** 2 females.

Distribution. CANADA: Quebec, Ontario, Saskatchewan, British Columbia. This is the first Alberta record. USA: West Virginia west to California.

Predators/parasitoids. Unknown,

Trophic level. Parasitoid. There are a wide variety of host records for this species. HYMENOPTERA: TENTHREDINIDAE: *Macremphytus* sp.; DIPRIONIDAE: *Diprion similis* (Hartig). COLEOPTERA: CURCULIONIDAE: *Mononychus vulpeculus* (Fabricius) LEPIDOPTERA: PYRALIDAE: *Acrobasis rubrifasciella* Packard; TORTRICIDAE: *Phaneta olivaceana* (Riley); NOCTUIDAE: *Eumicremma minima* (Guenee). Townes and Townes (1960) reported that the last 2 hosts are in doubt.

Pseudorhyssa: there is a single North American species.

28. **Pseudorhyssa maculicoxis (Kriechbaumer).** 1 male.

Distribution. CANADA: Quebec west to Alberta. This species was collected at Wagner. USA: south to North Carolina and west to California.

Predators/parasitoids. Unknown.

Trophic level. Cleptoparasitic? In North America this species has been associated with *Rhyssa howdenorum* Townes and *Rhyssa persuasoria* (Linnaeus) and is presumed cleptoparasitic on them (Krombein *et al.*, 1979).

RHYSSINI: members of this group are parasitoids of Siricoidea (Hymenoptera), wood-boring sawflies. Some members of the genus *Megarhyssa* are among our largest wasps, with females attaining up to 16 cm (over 6 inches) in length in one eastern species. There are 14 species in North America, 8 of them occur in Canada.

29. **Rhyssa pursuasoria pursuasoria (Linnaeus).** 1 male.

Distribution. CANADA: Newfoundland to British Columbia. USA: south to Georgia, west to California. EURASIA, NEW ZEALAND, AUSTRALIA. The last 2 records represent introductions for biological control of wood-boring sawflies.

Predators/parasitoids. *Pseudorhyssa maculicoxis* may be a cleptoparasitoid associated with this species.

Trophic level. Parasitoid. The following sawflies are reported as hosts: HYMENOPTERA: SYNTEXIDAE: *Syntexis libocedrii* Rohwer; SIRICIDAE: *Sirex areolatus* (Cresson), *S. noctilio* Fabricius, *Xeris* sp.

TRYPHONINAE: members of this subfamily are external parasitoids of the larvae of sawflies or Lepidoptera. The egg of these species is attached to the host by means of a holdfast on a stalk. The genera of the world were treated by Townes (1969). Collections from Bistcho Lake provided species from 3 tribes, Phytodietini, Tryphonini and Exenterini.

PHYTODIETINI: members of this tribe are parasitoids of Lepidoptera. There are 95 species in North America, 24 of them occur in Canada.

Phytodietus: the hosts for this genus are lepidopterous larvae in cryptic situations like rolled leaves (Townes 1969).

30. **Phytodietus (Phytodietus)** sp. 3 males.

Trophic level. Parasitoid.

TRYPHONINI: nearly all members of this tribe are parasitoids of sawflies. There are 110 species in North America of which 64 occur in Canada. Townes and Townes (1949) revised the tribe for the Nearctic Region.

Polyblastus: of the 23 North American species, 16 are found in Canada.

31. **Polyblastus (Labroctonus) buccatus Townes.** 1 female.

Distribution. CANADA: this species was taken at Wagner and together with the present record represent the only Canadian localities for this species. USA: Washington, California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

32. **Polyblastus (Labroctonus) stenocentrus** Holmgren. 1 male.

Distribution: CANADA: this is the first Canadian record for this species.USA: Alaska. EURASIA.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Ctenochira: like the preceding genus there are 23 described species in North America, 16 of them reported from Canada.

33. **Ctenochira pectoralis Townes.** 1 male, 1 female.

Distribution. CANADA: Quebec, Ontario. This is a new record for Alberta. USA: North Carolina.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Erromenus: Of the 18 North American species, 11 are known from Canada.

34. **Erromenus caelator Townes.** 2 females.

Distribution. CANADA: Ontario. This species was captured at Wagner and along with the present site represent the first Alberta records. USA: New York.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

35. **Erromenus punctulatus Holmgren.** 1 male.

Distribution. CANADA: Quebec. This species was captured at Wagner and together with the present locality represent the first Alberta records for the species. USA: New York west to New Mexico, Oregon, Alaska. EURASIA.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Monoblastus: of the 13 North American species, 5 are found in Canada.

36. **Monoblastus proximus Townes.** 1 male.

Distribution. CANADA: Bistcho Lake represents the first Canadian record for this species. USA: Idaho, Washington, Oregon, California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

EXENTERINI: members of this tribe are parasitoids of diprionid or tenthredinid sawfly larvae. There are 73 North American species, 61 are found in Canada.

Eridolius: this genus is in need of revision, many species are undescribed.

37. **Eridolius** sp. A. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

38. **Eridolius** sp. B. 1 male.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

39. **Eridolius** sp. F. 1 female.

Distribution. This species was collected only at Bistcho Lake.

Trophic level. Parasitoid.

ADELOGNATHINAE: there is a single genus and 5 described species in North America. Four species are found in Canada. Members of this group are gregarious ectoparasitoids of sawfly larvae.

Adelognathus: there are no keys to the species of this genus. In addition to the 2 species listed below, an additional 2 males are unassociated with the females. The following represent the first records for the genus in Alberta.

40. **Adelognathus** sp. E. 1 female.

Distribution. This species was also collected at Wagner.

Trophic level. Parasitoid.

41. **Adelognathus** sp. F. 1 female.

Distribution. This species was captured only at the Bistcho site.

Trophic level. Parasitoid.

BANCHINAE: members of this subfamily are internal parasitoids of lepidopterous larvae, often in cryptic situations like leaf rolls, stems or buds. Many species are important in biological control of lepidoptera in meadows and forests (Townes and Townes 1978). There are 327 species in North America of which 186 are reported from Canada. Three tribes were found in the Bistcho Lake fauna, Glyptini, Lissonotini and Banchini.

GLYPTINI: the genera in this tribe are in need of revision, there are no keys to species in any of the North American genera. Of the 50 described North American species, 18 have been reported from Canada.

Glypta: a very large genus whose members attack larvae of Lepidoptera in cryptic situations. Collections from the Wagner site have yielded 12 species of this genus based on comparison of females. The males could not be associated with the females and as a result the following species cannot be compared to those of the Wagner fauna.

42. Glypta sp. 1 male.

Trophic level. Parasitoid.

LISSONOTINI: like the previous tribe, members are parasitoids of lepidopterous larvae in cryptic habitats. Townes and Townes (1978) have revised the 200 North American species, 111 species occur in Canada.

Lissonota: a very large genus of nearly worldwide distribution, Townes and Townes (1978) report 143 species from the Nearctic Region.

43. **Lissonota amphithyris Townes.** 1 male.

Distribution. CANADA: Quebec, Saskatchewan, British Columbia. This is the first record of this species in Alberta. USA: North Dakota, South Dakota.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Townes and Townes (1978) reported that a specimen had been reared from a cossid moth (LEPIDOPTERA: COSSIDAE) in *Populus*.

44. **Lissonota clypeator vivida Cresson.** 1 male.

Distribution. CANADA: Ontario to British Columbia and Northwest Territories. USA: Pennsylvania to California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Townes and Townes (1978) reported the following prey associations: LEPIDOPTERA: NOCTUIDAE: *Crymodes devastator* (Brace); TORTRICIDAE: *Pandemis* sp.

45. **Lissonota uncata Townes.** 1 male.

Distribution. CANADA: Newfoundland to British Columbia and Yukon. USA: Michigan, Wisconsin, Alaska.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

BANCHINI: members of this tribe are parasitoids of larger caterpillars especially those pupating in the ground. In many cases oviposition is into the first or early instars. The parasitoid does not kill its host until the host forms a cocoon or pupal chamber (Townes and Townes 1978). There are 77 species in North America, 57 of which occur in Canada.

Exetastes: a large genus, the species occur in open grassland, meadows, shrubbery, or semidesert areas. Hosts are smooth-skinned caterpillars which pupate in the ground. Although 2 species were identified to generic level further determination was not possible due to lack of comparative material.

46. Exetastes sp. A. 2 males.

Trophic level. Parasitoid.

47. Exetastes sp. B. 1 male.

Trophic level. Parasitoid.

CTENOPELMATINAE: species of this subfamily are endoparasitoids of sawflies. Oviposition is into the sawfly egg or larva. The host is not killed until it has made its cocoon (Townes 1970b). The entire subfamily is in need of revision. There are 213 described species in North America, 114 of them reported from Canada. Members of 3 tribes were collected at Bistcho Lake, Ctenopelmatini, Pionini and Mesoleiini.

CTENOPELMATINI: species in this group are parasitoids of pamphiliid sawflies (Hymenoptera: Pamphiliidae). There are 20 North American species, 11 of them found in Canada.

Ctenopelma: further identification of the following species requires identified comparative material. Representatives of 4 other species were collected at Wagner.

48. Ctenopelma sp. F. 1 male.

Trophic level. Parasitoid.

Xenoschesis: further identification of the following species must await a revision of the genus. In addition to the female listed below, one male was collected but could not be positively associated with the female. Representatives of 3 other species were collected at Wagner.

49. Xenoschesis sp. D. 1 female.

Trophic level. Parasitoid.

Pionini: Townes (1970b) reports that these wasps oviposit into a host egg or very young larva and even when ovipositing into an egg, the host is not killed until after it has spun a cocoon. Of the 16 North American species, 10 are found in Canada.

Trematopygus: there is a single Nearctic species.

50. Trematopygus semirufus (**Cresson**). 1 female.

Distribution. CANADA: Quebec to southwestern British Columbia. This species was collected at Wagner. USA: New Jersey, Illinois, Colorado, Oregon.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

MESOLEIINI: considered among the taxonomically most difficult in the Ichneumonidae. There are 69 North American species of which 37 are reported from Canada.

Himerta: further identification of the following species must await a revision of the genus. Collections from Wagner produced 3 other species in this genus.

51. Himerta sp. D. 1 male.

Trophic level. Parasitoid.

Campodorus: a very large Holarctic genus. Further identification of the following species must await revision of the genus. In addition to the following, 2 males are unassociated. Collections from Wagner yielded 11 species of this genus.

52. Campodorus sp. C. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

53. Campodorus sp. E. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

54. Campodorus sp. L. 1 female.

Trophic level. Parasitoid.

55. Campodorus sp. M. 1 female.

Trophic level. Parasitoid.

PORIZONTINAE: members of this subfamily are endoparasitoids chiefly of Lepidoptera but a few genera are parasitoids on Coleoptera. Wahl (unpubl.) stated that considering this is probably the most economically important group of ichneumonids the chaotic systematics is unfortunate. Krombein *et al.* (1979) listed 385 species in North America although many more have been described since that time. The Canadian fauna consists of 265 species. Townes (1970b) provided keys to genera.

PORIZONTINI:

Bathyplectes: the known hosts for this group are weevils of the genus *Hypera* (Coleoptera: Curculionidae). The majority of the Nearctic species are undescribed.

56. Bathyplectes sp. L. 2 females.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

57. Bathyplectes sp. N. 1 male.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

Synetaeris: one species of this genus is known as a parasitoid of *Choristoneura fumiferana* (Clemens), the spruce budworm (Lepidoptera: Tortricidae).

58. Synetaeris sp. B. 1 female.

Distribution. This is the first Alberta record for this genus. The species was also collected at Wagner.

Trophic level. Parasitoid.

Dusona: members of this very large genus are parasitoids of Lepidoptera mostly of the family Geometridae. Walley (1940) provided a revision of the species in North America.

59. Dusona glauca caliginosa (**Walley**). 1 male.

Distribution. CANADA: Saskatchewan, Alberta. This species was captured at Wagner. USA: Alaska south to northern California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. Another subspecies *D. glauca glauca* (Norton) has been reported as a parasitoid on the following: LEPIDOPTERA: GEOMETRIDAE: *Eulithis diversilineata* (Hubner) and *E. gracilineata* (Guenee) (Krombein *et al.*, 1979).

60. **Dusona luctuosa (Provancher).** 1 male.

Distribution. CANADA: Quebec, Alberta, British Columbia. USA: Idaho, Arizona.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. This species is known to attack the following moths:

LEPIDOPTERA: GEOMETRIDAE: *Enypia venata* (Grote), *Hydriomena divisaria* (Walker) and *H. furcata* (Thunberg).

61. **Dusona vara (Walley).** 1 male.

Distribution. CANADA: Nova Scotia to Saskatchewan. This is a new record for Alberta, it was also collected at Wagner. USA: New Jersey, Pennsylvania, Michigan.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Dolophron: species of genus are apparently parasitoids of tenthredinid sawflies.

62. **Dolophron** sp. A. 1 female.

Distribution. This is the first record of the genus in Canada. The species was collected at Wagner.

Trophic level. Parasitoid.

Phobocampe: members of this genus are parasitoids of Lepidoptera in exposed situations. Like most of the genera in the Porizontinae, *Phobocampe* is in need of revision. Five males are unassociated with females.

63. **Phobocampe** sp. A. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

64. **Phobocampe** sp. C. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

65. **Phobocampe** sp. E. 3 females.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

66. **Phobocampe** sp. F. 1 female.

Distribution. This species was collected only at the Bistcho Lake site.

Trophic level. Parasitoid.

Tranosema: species of this genus have been reared from various small Lepidoptera.

67. **Tranosema** sp. 1 female.

Distribution. This species has been collected at Wagner.

Trophic level. Parasitoid.

Diadegma: a very large genus of worldwide distribution, the hosts are small and medium size Lepidoptera. The genus is in need of revision.

68. **Diadegma** sp. C. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

69. **Diadegma** sp. O. 1 female.

Distribution. This species was collected only at the Bistcho Lake site.

Trophic level. Parasitoid.

70. **Diadegma** sp. P. 1 female.

Distribution. This species was collected only at the Bistcho Lake site.

Trophic level. Parasitoid.

Hyposoter: a very large genus of worldwide distribution, the hosts are larval lepidopterans in exposed situations. Like the proceeding genus it is in need of revision.

71. Hyposoter sp. A. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

Olesicampe: another very large genus of worldwide distribution. Hosts at least in North America are sawfly larvae. Like other genera in this group *Olesicampe* is in need of revision.

72. Olesicampe sp. A. 1 male.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

73. Olesicampe sp. B. 1 female.

Distribution. This species was collected at Wagner.

Trophic level. Parasitoid.

MESOCHORINAE: members of this subfamily are hyperparasitoids usually of Braconidae and other Ichneumonidae but several records on Tachinidae (Diptera) exist. Krombein *et al.* (1979) noted that mesochorines have been reared from parasitoids in Lepidoptera, Symphyta (sawflies, Hymenoptera), Coleoptera, Miridae (true bugs, Hemiptera) and Psocoptera (psocids). Mesochorines insert the ovipositor into the secondary host and in turn locate the early instar larva or the egg of the primary parasitoid and oviposit inside the latter (Krombein *et al.* 1979). There are 128 species of mesochorines known from North America, 87 of them are reported from Canada. Dasch (1971) has revised the North American species.

Astiphromma: members of this genus have been reared from Tenthredinidae (sawflies) and Lepidoptera.

74. Astiphromma luculentum **Dasch.** 1 female.

Distribution. CANADA: British Columbia. This is a new record for Alberta. USA: Colorado, Washington.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid. Dasch (1971) reported 1 specimen reared from a tenthredinid sawfly.

Mesochorus: a very large genus of worldwide distribution.

75. Mesochorus curvulus **Thomson.** 1 male, 3 females.

Distribution. CANADA: transcontinental south of treeline. This species was collected at Wagner. USA: Alaska south to South Carolina, Kansas and northern California.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid. This species has been reared from parasitoids in a number of secondary hosts. HEMIPTERA: MIRIDAE: *Dicyphus* sp., *Halticus intermedius* Uhler, *Lopidea marginalis* Reut., *Lygus lineolaris* (Beauv.), *Phytocoris* sp., *Plagiognathus conicola* Knight, *P. politus* Uhler and *Slaterocoris stygicus* (Say). COLEOPTERA: CHRYSOMELIDAE: *Phyllotreta striolata* (Fabricius). LEPIDOPTERA: GEOMETRIDAE: *Melanolophia imitata* (Walker); NOCTUIDAE: *Autographa* sp. In addition to the above a few primary hosts are known. HYMENOPTERA: BRACONIDAE: *Leiophron* near *maculipennis* (Ashmead), *Peristenus* near *pallipes* (Curtis), *P. plagiognathi* (Loan), *Microctonus vittitae* Muesebeck.

76. Mesochorus dreisbachi **Dasch.** 1 female.

Distribution. CANADA: Quebec to British Columbia. This species was collected at Wagner. USA: Alaska south to Pennsylvania, Kansas and California.

Predators/parasitoids. Unknown.

Trophic level. Hyperparasitoid.

DIPLAZONTINAE: members of this subfamily are parasitoids on Diptera (flies) and most often on aphidophagous Syrphidae. There are 103 species in North America, 84 of them in Canada. Dasch (1964) has revised the species.

Syrphoctonus: a moderately large genus represented on all continents except Australia.

77. **Syrphoctonus nigritarsus fuscitarsus (Provancher).** 1 female.

Distribution. CANADA: Newfoundland to Yukon. USA: Alaska south to New York, California, New Mexico. MEXICO.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid. This species has been reported from the following fly species: DIPTERA: SYRPHIDAE: *Eupeodes volucris* Osten Sacken.

78. **Syrphoctonus pectoralis (Provancher).** 2 females.

Distribution. CANADA: Quebec to Yukon. This is a new Alberta record and was also collected at Wagner. USA: Alaska south to Virginia, Wisconsin, Colorado.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Enizemum: a small Holarctic, Ethiopian and Oriental genus.

79. **Enizemum tridentatum Dasch.** 3 females.

Distribution. CANADA: Alberta. This species was previously known only from the extreme southwestern corner of the province. USA: Alaska and northern Colorado.

Predator/parasitoids. Unknown.

Trophic level. Parasitoid.

Syrphophilus: a small Holarctic genus.

80. **Sryphophilus tricinctorius (Thunberg).** 2 females.

Distribution. CANADA: Quebec to Yukon. This species was collected at Wagner. USA: Alaska south to South Carolina, Missouri, New Mexico, California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Diplazon: a moderate size genus of worldwide distribution.

81. **Diplazon algidus Dasch.** 1 female.

Distribution. CANADA: Newfoundland to Yukon. This species was collected at Wagner. USA: Alaska and Colorado. GREENLAND. NORWAY.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

Sussaba: a moderate size genus found in the Holarctic, Neotropical and Oriental Regions.

82. **Sussaba cognata faceta Dasch.** 1 female.

Distribution. CANADA: Nova Scotia to British Columbia. This is a new record for Alberta. USA: south to Georgia in the east, California, Oregon, Washington, Alaska in the west.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

83. **Sussaba placita Dasch.** 1 female.

Distribution. CANADA: southeastern British Columbia. This is the first record of this species in Alberta. USA: northern California.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

84. **Sussaba punctiventris (Thomson).** 3 males.

Distribution. CANADA: Quebec to Yukon. This species was collected at Wagner. USA: south to Massachusetts, Michigan, Colorado, Arizona, Oregon. EUROPE.

Predators/parasitoids. Unknown.

Trophic level. Parasitoid.

OXYTORINAE: among the smallest in size and least known of the ichneumonids. A few species are

known to be parasitoids on Mycetophilidae and Tipulidae (Diptera). There are 44 described species in North America, 21 of them are known from Canada. Townes (1971) provided keys to genera. Since almost nothing is known the previous format is abandoned. The following are considered parasitoids for purposes of trophic level analysis in the discussion.

85. **Hyperacmus** sp. 1 female.

Distribution. CANADA: this is the first Canadian record for the genus. USA: one species is known from Alaska, New York and EURASIA.

Trophic level. Parasitoid.

86. **Entypoma** sp. 1 male, 1 female.

This is a small genus without described species in North America.

87. **Pantisarthrus** sp. A. 1 male, 1 female.

This genus has a single described Nearctic species from the east coast. This is the first record of the genus in Alberta, it was also collected at Wagner.

88. **Proclitus** sp. A. 1 female.

Two species are known in the Nearctic Region, this is the first record for the genus in Alberta, it was also collected at Wagner.

89. **Blapticus** sp. D. 1 male.

Although a large genus, none of the Nearctic species are described. Three other species were collected at Wagner.

90. **Eusterinx** sp. E. 1 male, 1 female.

A large genus with 6 described North American species. This is the first Alberta record for the genus. Four other species were collected from Wagner.

ORTHOCENTRINAE: the few records of this subfamily indicate they are endoparasitoids of Mycetophilidae and perhaps also Cecidomyiidae (Diptera). There are 30 species in North America, 18 of them are known from Canada. Townes (1971) provided keys to world genera but the only treatment of North American species is an unpublished doctoral thesis (Smith 1958).

Orthocentrus: a large genus of worldwide distribution, it contains most of the larger species in the subfamily (Townes 1971).

91. **Orthocentrus** sp. A. 2 females.

Trophic level. Parasitoid.

92. **Orthocentrus** sp. B. 2 females.

Trophic level. Parasitoid.

Stenomacrus: a large genus of worldwide distribution.

93. **Stenomacrus** sp. 2 females.

Trophic level. Parasitoid.

Family Pamphiliidae

Commonly called web-spinning sawflies, the larvae of these sawflies spin silk to form webs in which they feed. Some species are gregarious, living in large webs similar to those of the tent caterpillar. The North American fauna contains 71 species of which 55 are known from Canada. Middlekauff (1958, 1964) revised the Nearctic genera.

PAMPHILIINAE: members of this subfamily are associated with deciduous trees and shrubs.

Pamphilius: of the 16 North American species, 13 are found in Canada.

94. **Pamphilius ochreipes (Cresson).** 1 specimen.

Distribution. CANADA: transcontinental. USA: Alaska south to North Carolina and Alabama.

Predators/parasitoids. Unknown.

Trophic level. Herbivore. This species is associated with *Viburnum opulus.*

Family Tenthredinidae

With over 5,000 species, this is the largest family of sawflies. The caterpillar-like larvae feed externally on the foliage of the host plant but a few are leafminers or gall formers. The North American fauna is

about 800 species of which about 600 occur in Canada.

NEMATINAE: the dominant sawfly group in the arctic and subarctic regions of the world.

Priophorus: all 4 species in this genus are found in Canada.

95. **Priophorus pallipes (Lepeletier).** 2 specimens.

Distribution. CANADA: transcontinental. USA: Alaska south to Virginia, Tennessee, Illinois, Colorado, Oregon. EURASIA.

Predators/parasitoids. Unknown.

Trophic level. Herbivore. This species is reported to feed on *Prunus, Crataegus* and *Alnus.*

Pikonema: of the 3 species, 2 are found in Canada. They all feed on *Picea.*

96. **Pikonema alaskensis (Rohwer).** 1 specimen.

Distribution. CANADA: transcontinental. USA: Alaska south to Massachusetts, Michigan, Minnesota, Wyoming and Idaho.

Predators/parasitoids. The following have been reported as parasitoids of this species. HYMENOPTERA: BRACONIDAE: *Ichneutes pikonematis* Mason; ICHNEUMONIDAE: *Ctenochira pikonematis* Townes, *Aderaeon bedardi* (Provancher), *Excavarus velox* (Walley), *Mastrus laplantei* Mason, *Pleolophus indistinctus* (Provancher), *Syndipnus gaspesianus* (Provancher), *S. rubiginosus* Walley, *Olesicampe pikonemae* Walley. PTEROMALIDAE: *Tritneptis diprionis* Gahan.

Trophic level. Herbivore. This species feeds on *Picea* spp., the following have been reported: *Picea canadensis, P. engelmannii, P. excelsa, P. glauca, P. mariana, P. rubens, P. pungens, P. sitchensis* and *P. abies*.

Pristophora: a large cosmopolitan genus feeding on a wide variety of plants. The genus is in need of revision. Of the 45 described Nearctic species, 35 are known in Canada.

97. **Pristophora** sp. A. 4 specimens.

Trophic level. Herbivore.

98. **Pristophora** sp. B. 1 specimen.

Trophic level. Herbivore.

99. **Pristophora** sp. C. 1 specimen.

Trophic level. Herbivore.

Croesus: a small Holarctic genus with 4 North American species, 3 are found in Canada.

100. **Croesus latitarsus Norton.** 1 specimen.

Distribution. CANADA: Quebec to British Columbia and Yukon. USA: Alaska south to Florida, west to Utah.

Predators/parasitoids. The following has been reported. HYMENOPTERA: ICHNEUMONIDAE: *Polyblastus (Polyblastus) pedalis* (Cresson), *Excavarus annulipes* (Cresson), *Mesoleius tarsalis* (Cresson).

Trophic level. Herbivore. The species is reported feeding on *Betula.*

Nematus: a large Holarctic genus feeding on a wide variety of trees and shrubs. There are 60 described species in North America, 24 are known in Canada.

101. **Nematus** sp. A. 1 specimen.

Trophic level. Herbivore.

102. **Nematus** sp. B. 1 specimen.

Trophic level. Herbivore.

Phyllocolpa: a Holarctic genus, members of which feed on rolled leaves or leaf edges of *Salix* or *Populus.* There are 26 species in North America, 7 of them known from Canada. This genus is in need of revision.

103. **Phyllocolpa** sp. A. 1 specimen.

Trophic level. Herbivore.

104. **Phyllocolpa** sp. B. 1 specimen.

Trophic level. Herbivore.

Euura: members of this genus are either stem, twig or petiole gall formers on *Salix* and *Gemmura* or gall formers on buds of *Salix.* Identification of species in

this group is by host association, there are 32 species in North America, 9 of them found in Canada.

105. Euura sp. 1 specimen.

Trophic level. Herbivore.

ALLANTINAE: after feeding and developing on a host plant, the larvae of this subfamily seek out fruit, wood or other substances in which to bore a hole and pupate or overwinter.

Empria: a Holarctic genus of 9 species, 8 of which are found in Canada.

106. Empria ignota **(Norton).** 3 specimens.

Distribution. CANADA: Quebec west to British Columbia. USA: Alaska south to Pennsylvania west to Washington, Oregon and California.

Predators/parasitoids. Unknown.

Trophic level. Herbivore. Specimens of this species been captured on *Salix.*

Allantus: 3 of the 7 North American species have been introduced, 5 species are found in Canada.

107. Allantus albolabris **(Rohwer).** 1 specimen.

Distribution. CANADA: Saskatchewan, Alberta, British Columbia. USA: Alaska, Washington, Oregon.

Predators/parasitoids. Unknown.

Trophic level. Herbivore.

TENTHREDININAE: this subfamily contains the larger and more colorful species.

Pachyprotasis: a single Holarctic species is found in North America.

108. Pachyprotasis rapae **(Linnaeus).** 1 specimen.

Distribution. CANADA: transcontinental. USA: Alaska south to North Carolina, Tennessee, Missouri, New Mexico, California. EUROPE to SIBERIA.

Predators/parasitoids. Unknown.

Trophic level. Herbivore. In Europe this species has been reported from *Solidago, Scrophularia, Betonica, Fraxinus* and *Antirrhinum.*

RESULTS AND DISCUSSION

In the following comparisons of Bistcho Lake data to the Wagner peatland data, the Symphyta (sawfly families Pamphilidae and Tenthredinidae) are not considered in a quantitative fashion because species determinations were unavailable for the Wagner fauna. Futhermore, only those Wagner species collected in June (the Bistcho Lake sampling period) are considered although common species occurring outside those dates are indicated. This eliminates almost 75% of the known hymenoptera fauna of Wagner, in the groups considered, from the analysis (534 of 704).

There were a total of 208 species collected at both the Wagner and Bistcho sites over the June sampling period, of which only 25% are common to both sites (Fig. 3). The common species are divided into those occurring in both sites during the sampling period (Fig. 3. common species June) and those species collected at Bistcho but occurring at other times in the season at Wagner (Fig. 3. common species over the season). Their is an overall difference of 74% (percentage of species collected at a single site) in the species between the 2 peatlands.

There are 2 reasons for the large difference in species composition. First, the Wagner peatland is located in a warmer and dryer climate (mid-boreal continental wetland) and secondly Wagner possesses both bog and fen conditions, each presumably with a distinct fauna.

Trophic levels are used to describe the major energy transfer points existing in the food chain. In the study of trophic levels there are several universal concepts, some of which have bearing on the present study. First, biomass is concentrated towards the base of the system. The mass of plants must be greater than that of all herbivores which must in turn be greater than that of all predators. Secondly, beginning with herbivores, there are a number of food-chains radiating outwards in which predators become successively larger, while parasitoids and hyperparasitoids become progressively smaller than their hosts (Lindeman 1942). Finally, as the parasitoid strategy is approached there is an increase in species richness associated with the community (Figs. 4, 5).

The trophic levels of the wasp fauna (including sawflies) from Bistcho Lake are presented in Figure 6 and also presented with the family breakdown of species numbers in Table 2. The percentage of parasitoids (68.5) is not high for the Hymenoptera since the groups not considered are composed, almost entirely, of parasitoids. Inclusion of all groups likely would raise the parasitoid complement to about 85%. All other groups would be correspondingly reduced. Also presented in Figure 7 for *all data* from Bistcho Lake are those groups of organisms on which the Hymenoptera feed. Note the use of plants as hosts compared to Fig. 8 which excludes the plant-eating Symphyta (sawflies).

The trophic levels of the Hymenoptera collected during the June sampling period are presented in Figures 4 and 5 for both peatlands. In the Hymenoptera, the trophic level of predator describes a continuum from predator to cleptoparasitoid, parasitoid and hyperparasitoid strategies. True parasites also form part of this continuum but true parasitism is seldom encountered in the Hymenoptera and therefore is not included. Important differences exist between each of these groups, for instance a predator hunts multiple prey for sustenance while a parasitoid uses a host to maintain its progenies existence (Holling 1959).

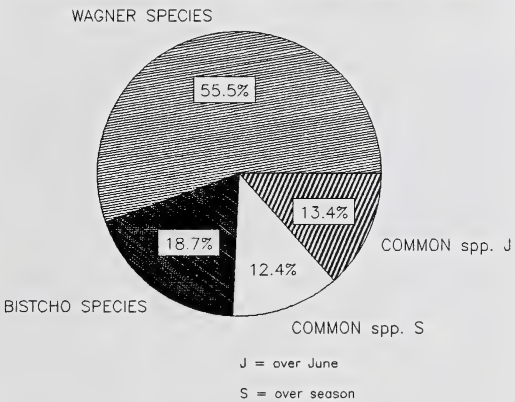

Figure 3. Comparison of peatland hymenoptera from Bistcho Lake and Wagner peatland with symphyta (sawflies) removed.

Comparison of species richness is the primary concern of this study. There are several reasons for high species richness in the parasitoid strategy. In the predator/parasitoid/hyperparasitoid continuum, a predator must consume multiple hosts over its lifetime to ensure reproductive success. Parasitoids require only a single host over their lifetime and because a successful oviposition virtually ensures reproductive success, they tend to lay fewer eggs. Parasitoid species have lower population sizes because of their position in the food chain. In terms of species richness this implies that large numbers of parasitoid species can compete for the same host resource. In the Wagner study this was expressed in the numbers of specimens per species collected over the season (more accurately it is a measure of relative trapability). The Wagner data show an average of 28.6 specimens for each of the 63 predator species. For parasitoids there was an average of 6.2 specimens per species but 507 species were collected. Finally, the parasite strategy, a single host can sustain multiple parasitic species, potentially contributing another order of magnitude to the complexity of a community.

The trophic levels of Hymenoptera indicated in Figures 4 and 5 show a similar proportion of parasitoids at both Wagner and Bistcho. The only sig-

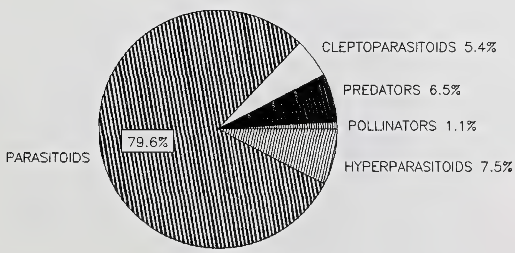

Figure 4. Trophic levels of Bistcho Lake hymenoptera with herbivores removed for Wagner comparison.

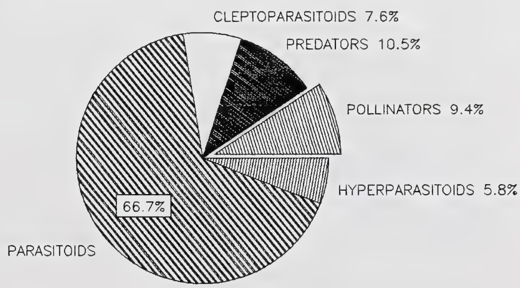

Figure 5. Trophic levels of Wagner peatland hymenoptera with symphyta (sawflies) removed.

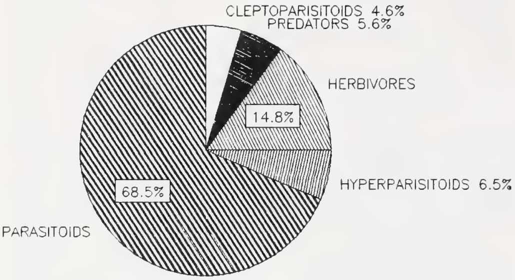

Figure 6. Trophic levels of Bistcho Lake hymenotera (all data).

nificant difference was the small number of pollinating species collected at the Bistcho site. This is likely a result of the short duration of the sampling period rather than a lack of pollinating species.

Host utilization by wasps at both sites is illustrated in Figures 8-11. Host utilization or those groups of organisms being consumed by wasps are presented in Figures 8 and 9. The assumption inherent in looking at host utilization is that Hymenoptera attack almost every stage of all insects and spiders (including other wasps) and any trends emerging from the analysis of wasps are relevant for the terrestrial insect fauna as a whole. The proportion of hosts attacked is similar between the sites except for plants where the Wagner

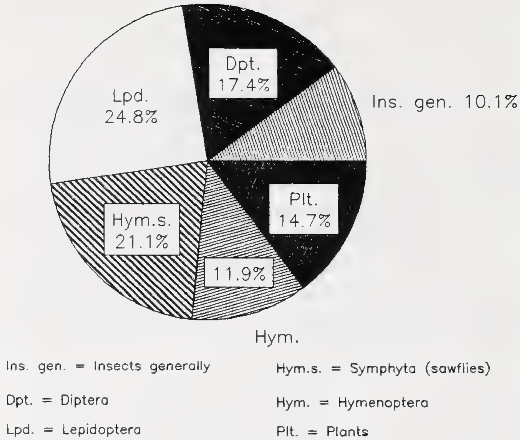

Figure 7. Host group utilization by hymenoptera at Bistcho Lake (all data).

site shows a 9-fold increase in the use of plants as a food source by wasps. This difference is directly attributable to higher numbers of pollinating species collected at Wagner. As mentioned above, low pollinator numbers at Bistcho are considered to represent an artifact of sampling period since pollinators were present at other Bistcho Lake habitats.

The Hymenoptera may be divided into 2 categories based on larval form. The predominant forms are the

Table 2. Summary Of Bistcho Lake Hymenoptera

Family	No. species	No. specimens	Trophic levels					
			HV	PL	PD	CP	PA	HP
ANTHOPHORIDAE	1	1		1				
LARRIDAE	1	2			1			
VESPIDAE	3	7			2	1		
FORMICIDAE	5	18			3	2		
DRYINIDAE	1	1					1	
CHRYSIDIDAE	1	1				1		
FIGITIDAE	1	1					1	
EUCOILIDAE	1	1					1	
CHARIPIDAE	4	5						4
ICHNEUMONIDAE	75	99				1	71	3
PAMPHILIIDAE	1	1	1					
TENTHREDINIDAE	14	20	14					
TOTALS	108	157	15	1	6	5	74	7

HV = herbivores, PL = pollinators, PD = predators, CP = cleptoparasitoids, PA = parasitoids, HP = hyperparasitoids

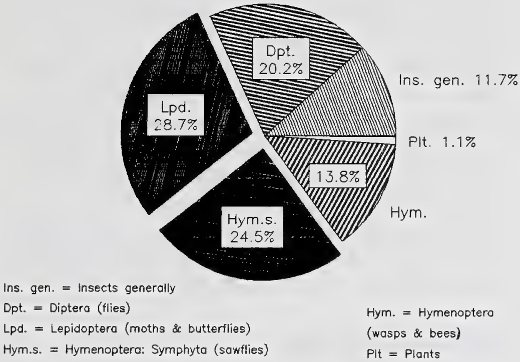

Figure 8. Host utilization by hymenoptera at Bistcho Lake.

almost featureless grub-like larvae that usually develop inside a host (parasitoids) or inside a specially constructed cell (predators and pollinators). The other larval form is that of a caterpillar, developed in the sawflies where the larvae are free living herbivores. In Figures 8 and 9 the shaded areas indicate that 54% of Hymenoptera at Bistcho and 41% at Wagner attack hosts which have a free living caterpillar-like larva. Both Symphyta (Hymenoptera) and Lepidoptera have larvae which occupy the same shrub or forest habitats. This would suggest that about 50% of all wasp species in these regions may be found in this environment. However, many hymenoptera were not considered in this study especially ground or soil inhabitants. They represent enough species to considerably alter the trends indicated above.

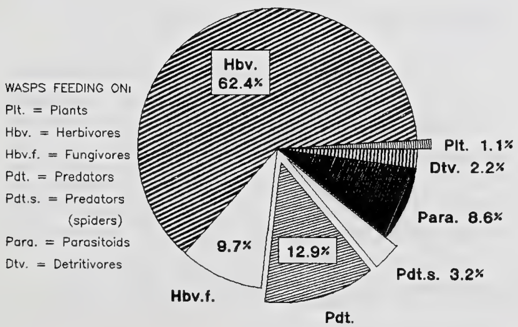

Figure 10. Trophic levels of hymenopteran hosts at Bistcho Lake.

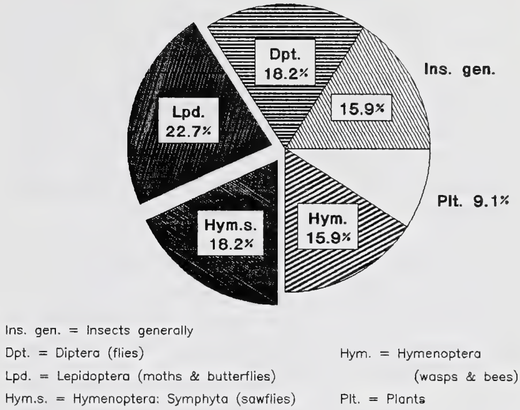

Figure 9. Host utilization by hymenoptera at Wagner peatland.

From examination of the trophic level of host groups, several trends begin to emerge. First the low percentage of wasps feeding on plants at Bistcho (Fig. 8) is likely an artifact of sampling pollinating species. Secondly, it is evident that over 50% of the Hymenoptera collected at both sites attack herbivores (Figs. 10, 9), an indication of the potential importance of wasps in limiting populations of defoliating insects. Finally the proportions of wasps feeding on fungivores and detritivores is almost exactly reversed between the sites.

In the Wagner site wasps attacking fungivores account for 2.4% of the wasp fauna while 8.9% of wasps attack detritivores. At Bistcho, 9.7% of wasp species attack fungivores and 2.2% attack detritivores. It is doubtful that this reversal is due to a

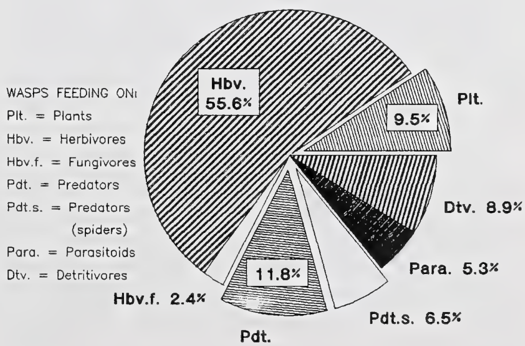

Figure 11. Trophic levels of hymenopteran hosts at Wagner peatland.

single cause. The greatest differences between the sites are related to soil temperature and secondly, peatland composition. The organic soils at Bistcho have very cold subsurface horizons which may contain permafrost. These very cold horizons restrict development of insect species, especially detritivores. By contrast, at the soil surface temperatures are warmer allowing fungi and its associated fauna to multiply.

The peatland soils at Bistcho are almost entirely composed of *Sphagnum*, a substance very few animals are capable of using as food, thus it is unsuitable to most detritivores in the area. The mixed peatland at Wagner allows a higher number of detritivore species because other plants, in addition to *Sphagnum*, contribute to peat formation. It is possible that increasing detritivore richness contributes to a lowering of fungivore richness due to competition for a somewhat similar resource. Detritivores ingest decomposing debris and derive energy by digesting fungi, algae, bacteria and the byproducts associated with their decomposition.

Collections of insects from Bistcho Lake yielded 50,000 to 70,000 specimens from a variety of habitats. This presentation considered only part of the Hymenoptera obtained from a single habitat, peatlands. Approximately 5,000 wasps were collected from all habitats sampled. Of these about 300 specimens were obtained from the peatland site, 157 specimens from 108 species were considered in this study. To put these figures in perspective, the wasp fauna at Bistcho Lake could be expected to encompass 58 families of Hymenoptera (93 families exist worldwide), the present paper treats only 12 of these families. The major groups not considered are the Proctotrupoidea, Scelionoidea, Ceraphronoidea, Chalcidoidea and the Braconidae in the Ichneumonoidea. Any interpretation of these data must be considered in light of the absence of these groups from the study.

Other sources of error potentially leading to misinterpretation of data are the sampling techniques and the short duration of the sampling period. The test of trapping techniques conducted at Bistcho for a single group (Carabidae) indicated that all trapping techniques taken together can be expected to sample about 60% of the species present. That figure is likely to vary depending on the relative trapability of species in a given family.

The short duration of the sampling period cannot account for effects due to seasonality (early or late spring) or the succession of species encountered as the season progresses. In the Wagner study these 2 factors were essentially eliminated by sampling over the duration of the activity period. Comparing the Wagner fauna with those groups of wasps considered from Bistcho, there are 170 species (versus 108) occuring in the time frame corresponding to the Bistcho Lake collecting dates. When considering the same groups of wasps over the entire sampling period at Wagner, there are 704 species represented

CONCLUSION

Although several factors contributing to sampling error have been identified and the data set is incomplete, there are, nevertheless, differences between the peatland sites.

Analysis of trophic levels indicates that even though Bistcho shows a 30% decline in richness and has only 26% of its species in common with Wagner, the trophic structure of the habitat remains essentially the same. The greatest differences in trophic structure between the 2 sites were observed in the fungivores and detritivores where the relative proportions of the respective faunas were almost exactly reversed.

Analysis of this data has indicated a number of trends within peatland fauna, but because of the incomplete nature of the data set and sampling error it would be premature to suggest that the trends are biologically meaningful. Once the complete data set has been processed the significance of these trends can be reassessed.

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ANNOTATED CHECKLIST OF CARABID BEETLES (COLEOPTERA: CARABIDAE) FROM BISTCHO LAKE, ALBERTA: A COMPARISON OF COLLECTING TECHNIQUES

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I participated in an expedition of the Alberta Provincial Museum to Bistcho Lake, in the northwest corner of Alberta, from 12 to 22 June 1987 to collect ground beetles in the family Carabidae. Most carabids are long-legged, quick running predators. They live in forest leaf litter, bogs and marshes, riparian habitats, or meadows and pastures. This research produced four carabid species records for Alberta and some interesting observations on collecting techniques.

The ground beetles of Alberta were studied by Lindroth (1961-1969) and new records added recently by Bousquet (1987) indicate that there are 58 genera and 334 species of carabids found in the province. Most collecting in the province has been done from the north central region to the Montana border. The trip to Bistcho Lake was an opportunity to sample species from the northern boreal forest.

A total of 601 specimens representing 18 genera and 46 species were collected near Tapawingo Lodge on the northeast edge of the lake. Two different collecting techniques were used: the first method used yellow pantraps with soapy water (see Finnamore, this volume). After choosing a suitable location in the area of interest, a depression was made for each pan so that any beetles running on the ground surface would fall into the pantrap. Soapy water was used to drown the specimens which were removed daily from the pantraps.

The second method (used by the author) involved searching under cover and on the ground for beetles. Deadfalls and stones were rolled over to see if specimens were underneath; cleared areas (dry and wet) were examined for beetles; leaf litter as well as shore litter was slowly separated so that specimens could be captured. A sifter was also used to extract specimens from leaf litter. Handfuls of leaf litter were removed to soil level from the bases of willows in mixed forest so that deep litter specimens were extracted as well as those found near the surface.

Most specimens were taken in moist areas at sites in which deciduous trees were growing. The surrounding spruce forest was dry and no specimens were found in the needle litter.

These 2 techniques produced rather different collections of carabids. Only 14 of the 46 species were collected by both methods (Table 1).

ANNOTATED CHECKLIST OF CARABIDS

The annotated checklist is taxonomically ordered rather than alphabetical. Notes about species are taken from Lindroth (1961-1969), Lindroth and Ball (1969), and Bousquet (1987). The Bistcho Lake collecting sites as recorded in the list are as follows:

BL1 -near the lake margin in poplar, willow, alder, and spruce, in accumulated leaf litter at the base of willows, 555 meters elevation.

BL2 -near the lake margin, in *Scirpus* debris, 555 meters elev.

BL3 -in a wet, cleared bog at end of the airstrip, 570 meters elevation.

BL4 -clearing along the side of the airstrip, clay, in cracks and under stones, 570 meters elevaion.

BL5 -clearing in spruce forest, under or near deadfall, 565 meters elevation.

BL6 -poplar and willow forest, in leaf litter, 570 meters elevation

BL7 -open poplar forest surrounding bog

BL8 -bog

Carabus taedatus Fabricius. Nearctic and nearly transamerican. A rather xerophilous species, prefer-

Table 1. List of carabid species collected at Bistcho Lake, Alberta from 12-22 June 1987.

Species	Numbers caught by		Habitat (BL sites)							
	traps	searching	1	2	3	4	5	6	7	8
Carabus taedatus Fabricius	1	-	-	-	-	-	-	X	-	-
Carabus chamissonis Fischer von Waldheim	20	6	X	-	-	-	-	-	-	-
Pelophila rudis LeConte	-	9	X	X	-	-	-	-	-	-
Nebria gyllenhali castanipes Kirby	-	1	-	X	-	-	-	-	-	
Notiophilus semistraitus Say	3	-	-	-	-	-	-	-	-	X
Notiophilus borealis Harris	1	-	-	-	-	-	-	-	X	-
Notiophilus intermedius Lindroth	2	-	-	-	-	-	-	-	-	X
Elaphrus lapponicus lapponicus Gyllenhal	3	-	-	-	-	-	-	X	-	-
Elaphrus clairvillei Kirby	-	1	-	X	-	-	-	-	-	-
Elaphrus americanus Dejean	1	12	-	-	X	-	-	-	-	-
Loricera pilicornis Fabricius	1	1	-	-	X	-	-	-	-	-
Dyschirius hiemalis Bousquet	9	-	-	-	-	-	-	-	-	-
Trechus apicalis Motschulsky	1	10	X	-	-	-	-	-	-	-
Bembidion grapei Gyllenhal	-	9	X	-	X	X	-	-	-	-
Bembidion sordidum Kirby	-	12	-	-	X	X	-	-	-	-
Bembidion rupicola Kirby	-	1	-	-	-	X	-	-	-	-
Bembidion incrematum Lindroth	-	6	-	-	X	-	-	-	-	-
Bembidion coloradense Hayword	-	9	-	-	X	-	-	-	-	-
Bembidion rapidum LeConte	-	1	-	-	X	-	-	-	-	-
Bembidion nigripes Kirby	-	36	-	-	X	X	-	-	-	-
Bembidion versicolor LeConte	-	22	-	-	X	X	-	-	-	-
Bembidion quadrimaculatum dubitrans LeConte	-	8	-	-	-	X	-	-	-	-
Bembidion mutatum Gemminger & Harold	-	2	-	-	-	X	-	-	-	-
Bembidion morulum LeConte	-	2	X	-	-	-	-	-	-	-
Patrobus foveocollis Eschscholtz	3	2	X	-	-	-	-	-	-	-
Pterostichus adstrictus Eschscholtz	23	24	X	-	-	X	X	-	-	-
Pterostichus pensylvanicus LeConte	4	-	X	-	-	-	-	-	-	-
Pterostichus brevicornus/empetricola	2	42	X	-	-	-	-	-	-	X
Pterostichus mandibularoides Ball	-	14	X	-	-	-	-	-	-	-
Pterostichus punctatissimus Randall	19	5	X	-	-	-	X	-	X	X
Pterostichus haematopus Dejean	52	32	X	-	-	-	-	-	X	X
Calathus ingratus Dejean	89	42	X	-	-	-	-	X	X	X
Agonum consimile Gyllenhal	1	-	-	-	-	-	-	-	-	X
Agonum retractum LeConte	14	11	X	-	-	-	-	-	X	-
Agonum gratiosum Mannerheim	1	3	X	-	-	-	-	-	-	X
Agonum quinquepunctatum Motschulsky	-	1	-	X	-	-	-	-	-	-
Agonum corvus LeConte	-	1	X	-	-	-	-	-	-	-
Agonum affine Kirby	-	1	X	-	-	-	-	-	-	-
Agonum placidum Say	1	-	-	-	-	-	-	-	-	X
Platynus decentis Say	2	3	X	-	-	-	-	-	-	-
Harpalus fulvilabris Mannerheim	3	-	-	-	-	-	-	-	X	-
Harpalus ochropus Kirby	2	-	-	-	-	-	-	-	X	-
Trichocellus cognatus Gyllenhal	-	4	X	-	-	-	-	-	-	-
Trichocellus mannerheimi Sahlberg	1	1	X	-	-	-	-	-	-	-
Metabletus americanus Dejean	4	-	-	-	-	-	-	X	-	-
Cymindis unicolor Kirby	4	-	-.	-	-	-	-	-	-	X

ring open, gravelly soil (usually moraine) with poor vegetation; also in open conifer forest. **BL6.**

Carabus chamissonis Fischer von Waldheim. Nearctic and transamerican at high latitudes. Primarily an inhabitant of the open dry country (usually moraine), particularly on the tundra; only in central Canada at several localities in the conifer region (e.g. North Saskatchewan River valley at Edmonton) **BL1, BL7.**

Pelophila rudis LeConte. A rare and local species, restricted to Canada. Hygrophilous, most specimens taken near the lake margin, in *Scirpus* debris. **BL1, BL2.**

Nebria gyllenhali castanipes Kirby. Transamerican. A hygrophilous species, most adults near the stony margins of running cold water. The single specimens was taken with the specimens of *Pelophila rudis*. **BL2.**

Notiophilus semistriatus Say. Transamerican. On open gravelly, rather dry ground, often moraine, with thin, low vegetation. **BL8.**

Notiophilus borealis Harris. Transamerican at high latitudes. Rather xerophilous, in open country with thin vegetation (moss, etc.). Specimens taken above timber limit as well as on the tundra. **BL7.**

Notiophilus intermedius Lindroth. Known only from a few localities in Canada and Alaska. On open ground, apparently usually where the soil is sandy. This species has not been previously recorded from Alberta. **BL7.**

Elaphrus lapponicus lapponicus Gyllenhal. Holarctic and transamerican. Almost exclusively in the boreal coniferous region, in damp open places with cold water and moss vegetation, and in *Sphagnum* bogs. **BL6.**

Elaphrus clairvillei Kirby. Transamerican. This species prefers shorelines shaded by trees and bushes or with high *Carex-Amblystegium* vegetation, with bare spots of mud or organic detritus. **BL2.**

Elaphrus americanus Dejean. Transamerican and mainly northern. A hygrophilous species occurring in moist or wet soil on or near the border of standing or slowly running water, where the ground is bare, at least in spots. Adults are heliophilous and run about quickly in the sunshine hunting for flies and other insects. **BL3.**

Loricera pilicornis Fabricius. Circumpolar and transamerican. Mostly hygrophilous, at the border of fresh, usually standing water, particularly where the soil is rich in organic matters and is shaded. **BL3.**

Dyschirius hiemalis Bousquet. Known only from a few localities in Canada and Alaska. This species is not riparian and the adults occur on moist, peaty soil. **BL8.**

Trechus apicalis Motschulsky. Transamerican. A eurytopic species, most specimens taken on gravelly or peaty soil, among dead leaves under bushes in more or less shaded areas. **BL1.**

Bembidion grapei Gyllenhal. Circumpolar. Not riparian, occurring on rather dry gravel (usually moraine) mixed with fine sand, where the vegetation is sparse. Some sandy sites supported only tiny *Polytrichum* sp. (moss). **BL1, BL3, BL4.**

Bembidion sordidum Kirby. Transamerican, though apparently not reaching the Pacific Coast. On moist clayey soil with sparse vegetation, along the banks of rivers, but at some distance from the water. **BL3, BL4.**

Bembidion rupicola Kirby. On the prairie and westward. This species is not confined to the vicinity of water, though adults occur in the upper zones of river banks. It is strongly xerophilous and occurs in cultivated fields, in gravel pits, under poplars in leaf litter, and also at saline localities. **BL4.**

Bembidion incrematum LeConte. Transamerican and mainly northern. At the border of fresh, standing or running waters. In generally shaded places where the soil is wet, mixed with dead leaves, twigs, etc. and the vegetation is sparse. **BL3.**

Bembidion coloradense Hayward. From Manitoba west and south. On wet clay close to water, with sparse vegetation of *Eleocharis*, *Carex*, *Equisetum*, etc. Common at moderately alkaline sloughs and ponds on the prairie, but not halobiontic. **BL3.**

Bembidion rapidum LeConte. East of the Rockies, and south, but apparently not reaching the Atlantic Coast. Most specimens are collected on sandy lake shores, often in great abundance (probably as the result of wind-borne transportation). **BL3.**

Bembidion nigripes Kirby. Transamerican and mainly northern. At the margins of pools and lakes (a

few adults taken in alkaline places). On moist, rather firm ground (often clay) with a sparse cover of grasses and other vegetation. **BL3, BL4.**

Bembidion versicolor LeConte. Transamerican and predominantly northern. A hygrophilous but otherwise very eurytopic species. On moist, bare sand, clay, or peat, with a mixture of organic matter. **BL3, BL4.**

Bembidion quadrimaculatum dubitans LeConte. Western. On almost bare soil, in moist sites with fine sand or clay. Found in upper areas of lake shores and river banks, but not confined to the vicinity of open water. Common in many cultivated fields. **BL4.**

Bembidion mutatum Gemminger and Harold. Transamerican and predominantly northern. On open, moderately moist spots of fine sand (many sites moraine) with tiny mosses or other very sparse vegetation. **BL4.**

Bembidion morulum LeConte. A northern, almost transamerican species. In Newfoundland taken on moist peaty soil on the coastal tundra. **BL1.**

Patrobus foveocollis Eschscholtz. Transamerican. This is the least hygrophilous species among North American *Patrobus*; it has no association with water. Most adults have been taken in slightly shaded places, for instance under dead leaves from alder bushes, in rotten logs, and on some morainic sites. **BL1.**

Pterostichus adstrictus Eschscholtz. Holarctic and transamerican. A characteristic beetle of the boreal coniferous region, mainly occurring in open country on moderately dry soil. **BL1, BL4, BL5.**

Pterostichus pensylvanicus LeConte. Transamerican but apparently not quite reaching the Pacific Coast. Among dead leaves and moss under alder bushes and on gravel soil in many sites. **BL1.**

Pterostichus brevicornis/empetricola. The 44 specimens are all females. *P. brevicornis* Kirby is Holarctic in distribution. In forested country under alders and other shrubs, mostly near the treeline. *P. empetricola* Dejean, believed to be parthenogenetic, occurs only in northern British Columbia, the Yukon, Alaska, and eastern Siberia. On the mainland among leaves under *Alnus* and *Salix* in most sites. Neither of these two species has previously been recorded from Alberta. **BL1, BL7, BL8.**

Pterostichus mandibularoides Ball. Northwestern Canada. At most sites among dead leaves of *Salix* and *Alnus* on generally sandy soil, near rivers. This species has not previously been recorded from Alberta. **BL1.**

Pterostichus punctatissimus Randall. In the northern coniferous region east of the Rocky Mountains. In conifer or mixed forests, many specimens under bark and moss on tree stumps. Not found above the treeline but is near it at Churchill, Manitoba. **BL1, BL5, BL7, BL8.**

Pterostichus haematopus Dejean. Holarctic. In North America a characteristic carabid of the tundra, occurring in the northern coniferous region. Abundant on the tundra, on rather dry, sandy soil, with *Empetrum* and other ericaceous shrubs. **BL1, BL7, BL8.**

Calathus ingratus Dejean. Nearctic and transamerican. The normal habitat of this species is among dead leaves and moss under bushes and deciduous trees on moderately moist or rather dry, gravelly ground. **BL1, BL6, BL7, BL8.**

Agonum consimile Gyllenhal. Holarctic and transamerican. Hygrophilous, occurring at the border of ponds or in swamps with a dense vegetation of *Carex* spp. and *Menyanthes*. **BL8.**

Agonum retractum LeConte. Transamerican, but very local. This species is not hygrophilous, but is a true forest insect. It lives among the debris of leaves, ferns, etc., and under bushes and hardwood trees. **BL1, BL7.**

Agonum gratiosum Mannerheim. Transamerican, mainly in north. Less hygrophilous than its relatives (except *A. retractum*) and rather eurytopic. It lives on open, moderately moist ground, sometimes with a considerable peat content. Found among *Sphagnum* at a few sites and on firm soil with Carex spp. at most sites. It is independent of open water. **BL1, BL8.**

Agonum quinquepunctatum Motschulsky. Holarctic. This species has been collected in a peat bog at Edmonton. The single specimen was taken near the lake margin in *Scirpus* debris. **BL2.**

Agonum corvus LeConte. Nearly transamerican (from Quebec to British Columbia). Mainly a species of the interior, on the prairie at the margin of sloughs, among *Eleocharis acicularis* and *E. palustris*, *Carex* spp., and *Juncus* with clayey soil. **BL1.**

Agonum affine Kirby. Transamerican and mainly northern. Hygrophilous, at the margin of ponds and in swamps with a dense cover of *Carex* spp. and *Menyanthes* with a brown moss carpet. **BL1.**

Agonum placidum Say. Transamerican but apparently not reaching the Pacific Coast. A markedly xerophilous species, occurring in open, usually sandy country. Often on cultivated soil among weedy vegetation and in sandpits. **BL8.**

Platynus decentis Say. Transamerican. Mostly a forest dwelling species with many specimens found under bark and logs. Rather hygrophilous however, and therefore regularly near water (e.g., on shady river banks). **BL1.**

Harpalus fulvilabris Mannerheim. Transamerican in the north. In Alberta it inhabits moderately dry leaf humus under bushes and deciduous trees. **BL7.**

Harpalus ochropus Kirby. Local and rare in the interior, from Ontario to British Columbia. In Ontario and Alaska it is found on sandy moraine in exposed positions with a sparse vegetation cover. **BL7.**

Trichocellus cognatus Gyllenhal. Holarctic. In forested areas, both in the north and in the mountains, but occurring in open or thinly wooded places. In many sites it is found on dry, sandy moraines, with a sparse cover of Polytrichum moss. **BL1.**

Trichocellus mannerheimi Sahlberg. Holarctic. On the tundra and in the upper forest region. In McKinley Park taken on a dry slope of sandy moraine with sparse, low vegetation. This species has not been previously recorded from Alberta. **BL1.**

Metabletus americanus Dejean. Transamerican. Adults xerophilous and heliophilous, occurring on sandy, rarely peaty soil with sparse, low vegetation (e.g., *Rumex acetosella*). **BL6.**

Cymindis unicolor Kirby. Transamerican. In treeless areas, above the timber line, and on the tundra. **BL8.**

CONCLUSION

This report should not be considered a comprehensive list of the carabid fauna of the Bistcho Lake area. The collected specimens represent about one third and one seventh of the known Alberta genera and species respectively. To sample the Carabid fauna adequately, different collecting techniques should be used over the course of the season in as many habitats as possible. I believe that the number of genera and species known from the Bistcho Lake site could be increased with more extensive collecting.

A comparison of collecting techniques is shown in Table 2. Pan trapping produced 13 species which were not taken by searching, and searching produced 19 species not taken by pan trapping. All the species were classified according to moisture preference and diel activity pattern (Table 2). The results indicate that searching was the more effective method for collecting hygrophilous and mesophilous carabids, while pan trapping was better for xerophilous species.

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Table 2. Comparison of collecting techniques for species of carabids at Bistcho Lake in relation to moisture preference and diel activity.

Species	Diel Activity			
	day		night	
Hygrophilous				
Pelophila rudis LeConte				S
Nebria gyllenhali castanipes Kirby		S		
Elaphrus lapponicus lapponicus Gyllenhal	PT			
Elaphrus clairvillei Kirby		S		
Elaphrus americanus Dejean	PT	S		
Loricera pilicornis Fabricius			PT	S
Dyschirius hiemalis Bousquet			PT	
Bembidion incrematum Lindroth		S		
Bembidion coloradense Hayward		S		
Bembidion nigripes Kirby		S		
Bembidion versicolor LeConte		S		
Agonum consimile Gyllenhal	PT			
Agonum quinquepunctatum Motschulsky		S		
Agonum affine Kirby		S		
Platynus decentis Say			PT	S
Mesophilous				S
Carabus chamissonis Fischer von Waldheim			PT	S
Trechus apicalis Motschulsky			PT	S
Bembidion grapei Gyllenhal				S
Bembidion sordidum Kirby				S
Bembidion rapidum LeConte				S
Bembidion morulum LeConte				S
Patrobus foveocollis Eschscholtz			PT	S
Pterostichus adstrictus Eschscholtz			PT	S
Pterostichus pensylvanicus LeConte			PT	
Pterostichus brevicornis/empetricola			PT	
Pterostichus mandibularoides Ball				S
Pterostichus punctatissimus Randall			PT	S
Pterostichus haematopus Dejean			PT	S
Calathus ingratus Dejean			PT	S
Agonum retractum LeConte			PT	S
Agonum gratiosum Mannerheim			PT	S
Agonum corvus LeConte				S
Harpalus fulvilabris Mannerheim			PT	S
Harpalus ochropus Kirby			PT	
Trichocellus cognatus Gyllenhal				
Trichocellus mannerheimi Sahlberg			PT	S
Cymindis unicolor Kirby			PT	S

PT = species caught in pan traps
S = species caught by searching

cont.

Table 2. cont.

Species	Diel Activity	
	day	night
Xerophilous		
Carabus taedatus Fabricius		PT
Notiophilus semistriatus Say	PT	
Notiophilus borealis Harris	PT	
Notiophilus intermedius Lindroth	PT	
Bembidion rupicola Kirby	S	
Bembidion quadrimaculatum dubitans LeConte	S	
Bembidion mutatum Gemminger & Harold	S	
Agonum placidum Say	PT	
Metabletus americanus Dejean	PT	

PT = species caught in pan traps

S = species caught by searching

DESCRIPTION OF THE DIPTERA FAMILIES COLLECTED AT THE WAGNER AND BISTCHO PEATLANDS

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The Diptera are an order of insects comprising the true (two-winged) flies. Familiar insects such as midges, mosquitoes, black flies, horse flies, hover flies, house flies, blow flies and many others belong to this order, which in total comprise more than 100 families in the world. Most of these families are represented in Canada, but with fewer species than are found in North America as a whole.

It has been estimated that there are more than 18,000 described species of Diptera in North America, with about 7,000 of these recorded from Canada (McAlpine 1979). The known number of Diptera species in Canada represents about half the number expected given the species still unrecorded or undescribed.

METHODS

Study of the Diptera collected at the Wagner Natural Area (9 km west of Edmonton) and Bistcho Lake (northwestern Alberta) is still in the embryonic stage. To date, the Diptera of both areas have been sorted to family (with the exception of a few acalyptrate families), and await identification to species by specialists. The purpose of this paper is to record the families of Diptera collected from each area, and to provide a short statement about the general biology of each.

Arthropod sampling in the Wagner peatland lasted from May to September, 1985. As collecting in the Bistcho peatland was only possible from 13-22 June, 1987, a similar sampling period (12-15 June, 1985) from the Wagner data was chosen for comparison of the Diptera families at each site. Only samples taken in pan traps are considered in this comparison (13 traps at Wagner, 4 at Bistcho).

RESULTS AND DISCUSSION

The Diptera families recorded from Wagner and Bistcho are listed in Table 1. Families are given in the order followed by the Manual of Nearctic Diptera, by McAlpine *et al.* (1987).

Of the 100+ families of Diptera known from Canada, 34 are recorded from Wagner and/or Bistcho (with several more likely to be added when the unidentified acalyptrate Diptera are sorted and identified). Of this total, eight are recorded only from Wagner (Rhagionidae, Stratiomyiidae, Asilidae, Lonchopteridae, Pipunculidae, Micropezidae, Dryomyzidae and Sepsidae) and two uniquely from Bistcho (Simuliidae and Heleomyzidae). I expected a greater difference between these sites given the larger number of pan traps at Wagner and the higher latitude of Bistcho. However, the effects of the latter probably are reduced by considering only families. A comparison at the species level between Wagner and Bistcho might show a greater difference.

Each family of Diptera recorded from Wagner and/or Bistcho is briefly discussed below. The feeding habits of larvae and adults are reviewed, with some additional notes about distinctive features and distribution. In addition to acquainting the reader with the general habits of the Diptera families recorded from the two sites, the following will also give an indication of which families are apt to be most diverse and common in peatlands.

TIPULIDAE (crane flies) - The Tipulidae are the largest family of Diptera, and with approximately 1,500 species, the most speciose family of Diptera in North America. Larvae occur in a variety of habitats ranging from aquatic to terrestrial, though most species are found in moist environments. Adults have long legs, a slender body and narrow wings, and are sometimes mistaken for giant mosquitoes because of their superficial resemblance to members of that family. Adult crane flies however, have non-biting mouthparts and are quite harmless. Adults of most species avoid areas of direct sunlight, preferring to remain in shaded situations near their larval habitat.

MYCETOPHILIDAE (fungus gnats) - Larvae of most species of this family live in decaying vegetation or fungus. Adults are found near the larval habitat, generally frequenting damp and shaded areas. The enlarged coxae of mycetophilids easily distinguish

Table 1. Families of Diptera recorded from trap sites on the Wagner and Bistcho peatlands.

Family	Wagner	Bistcho	Families	Wagner	Bistcho
Tipulidae	X[1]	X	Syrphidae	X	X
Mycetophilidae	X	X	Pipunculidae	X	---
Sciaridae	X	X	Micropezidae	X	---
Cecidomyiidae	X	X	Dryomyzidae	X	---
Psychodidae	X	X	Sciomyzidae	X	X
Scatopsidae	X	X	Sepsidae	X	---
Culicidae	X	X	Heleomyzidae	---	X
Simuliidae	---[2]	X	Sphaeroceridae	X	X
Ceratopogonidae	X	X	Ephydridae	X	X
Chironomidae	X	X	Chloropidae	X	X
Tabanidae	X	X	Scathophagidae	X	X
Rhagioniae	X	---	Anthomyiidae	X	X
Stratiomyiidae	X	---	Muscidae	X	X
Asilidae	X	X	Calliphoridae	X	X
Empididae	X	X	Sarcophagidae	X	X
Dolichopodidae	X	X	Tachinidae	X	X
Lonchopteridae	X	---	Undet. Acalyptratae	X	X
Phoridae	X	X			

1. X = family present; 2. --- = family absent

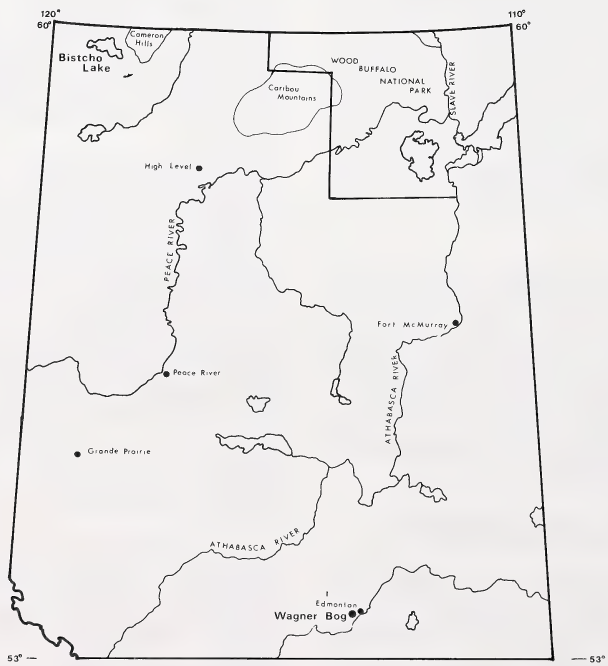

Figure 1. Locations of the Bistcho Lake and Wagner Bog study locations in Alberta.

species of this family from other Nematocera, including the related Sciaridae.

SCIARIDAE (dark-winged fungus gnats) - This group is classified by some authors as part of the closely related Mycetophilidae. Like members of that family, sciarid larvae are typically found in decaying plant material or fungus. Adults of most species are rather small and brownish flies. Sciarids were present in high numbers in both the Wagner and Bistcho pan traps.

CECIDOMYIIDAE (gall midges) - Larvae of this large family are mostly gall-makers or mycophagous (fungus-feeders) in decaying vegetation. Adults are tiny, fragile flies with a tapered abdomen and reduced venation. Cecidomyiids are a difficult and understudied group taxonomically, with about 100 described and many undescribed species in North America.

PSYCHODIDAE (moth and sand flies) - Of the two main psychodid subfamilies - the Psychodinae (non-biting moth flies) and Phlebotominae (blood-feeding sand flies) - only the former are found in Canada. Moth flies are aptly named, as with their hairy body wing veins, and wings held roof-like over the body at rest, they resemble diminutive moths. Larvae of moth flies are semi-aquatic or aquatic, with some species living under low oxygen, high organic matter, conditions. Moth flies occasionally become minor pests in households by breeding in drain pipes.

SCATOPSIDAE - As implied by the prefix "scat", larvae of some species of this family live in dung; larvae of others live in varied types of decaying plant and animal matter. Adults are generally small, dark-colored, robust flies with short antennae and non-biting mouthparts. The family is primarily north temperate in distribution, with fewer than 100 species in North America.

CULICIDAE (mosquitoes) - Standing water, including such sources as ponds, marshes and temporarily flooded fields, is the larval habitat of most mosquito species. Peat bogs, with low pH (acidic) water, are generally unsuitable for larval development. Adult mosquitoes have a long proboscis, though only in females is this adapted for blood-feeding. Mosquitoes are widely distributed throughout the world and are major vectors of disease-causing organisms. Encephalitis is transmitted by mosquitoes in parts of Canada, while in other regions of the world mosquitoes are responsible for the spread of malaria, yellow fever, and some types of filariasis.

SIMULIIDAE (black flies) - Black fly larvae live in fast flowing water. By attaching their hind end to a rock or other object and holding their head in the current, they are able to filter micro-organisms from the water with a pair of retractable head fans. Adults are small, humpbacked insects, with short antennae and broad wings. Adult females are blood-feeders, with some species specializing on amphibians, birds or other vertebrates. Black flies may cause considerable discomfort to man and domestic animals when present in numbers, and may cause significant economic losses to cattlemen by preventing herds from feeding normally. In some parts of the world, black flies are responsible for the spread of serious diseases (e.g., river blindness). Black flies are generally uncommon in bogs unless flowing water suitable for larval development is nearby.

CERATOPOGONIDAE (biting midges) - Both larvae and adults of this family are generally found in damp habitats, with some species breeding in or near bogs. Adults of most species are tiny, often only one to several mm long. Females are blood-feeders, with some species feeding only on other insects and others feeding on vertebrates, including man. Despite their small size, ceratopogonids have a painful bite similar to that of a black fly. These insects are commonly known as "no-see-ums" because of their ability to attack unseen. Ceratopogonids are not known vectors for any human diseases, though one species is a vector of bluetongue virus in cattle and sheep.

CHIRONOMIDAE (midges) - Non-biting midges of the family Chironomidae are soft-bodied, slender flies of small to medium size. These are common flies, often seen in large swarms in damp environments. Larvae live in varied types of aquatic habitats, generally feeding on small particles of plant and animal matter, though a few species are carnivorous. Some species are recognized as key indicators of environmental pollution because they have very narrow and specific ecological requirements; for example, some cannot survive in water relatively low in oxygen content. Chironomids of all life stages often occur in high numbers, and though small, constitute an important source of food for a variety of invertebrates and vertebrates.

TABANIDAE (horse and deer flies) - These are medium to large, swift-flying insects, notorious for their vicious bite and persistent attack. Commonly found near water, they are sometimes a serious pest on public beaches. In contrast to their drab-colored bodies, the eyes of tabanids are brightly banded, with different patterns in most species. Deer flies are generally smaller than horse flies, and easily recognized by their dark-banded wings. As in the Nematocera, only the females are blood-feeders. Larvae are carnivorous, chiefly inhabiting damp sand or wet soil near flowing water, marshes or bogs. Tabanids were present in large numbers at Wagner and Bistcho, though under-represented in pan trap samples.

RHAGIONIDAE (snipe flies) - Although fairly common, these medium-sized flies are usually restricted to damp, vegetated areas. Their habits are not well known, though larvae are thought to feed mainly on decaying plant and animal matter in soil, while adults are probably mostly predacious. Adult females of some species are blood-feeders, and occasionally are pests of man.

STRATIOMYIIDAE (soldier flies) - This relatively large family is uniformly distributed worldwide, with about 250 species in North America. Adults are variable in size and appearance, though many of the larger species possess a broad, flattened abdomen which is dorsally banded in black and yellow or black and green. They are most commonly seen on flowers or vegetation in fields, disturbed habitats or along forest edges, though seldom in numbers. Adults are mostly nectar-feeders, while larvae live in decaying organic matter and dung or are root-feeders or carnivores.

ASILIDAE (robber flies) - Asilids are small to very large flies, generally robust and rather elongate, with a hairy face and sunken vertex between the eyes. They are fierce predators, most common in open sunny areas, where they are often seen darting after a passing insect from an observation post on a twig or a leaf. Larvae are chiefly found in soil or rotting wood, where they are predators on other insects. The family is well represented in North America, with nearly 1,000 species recorded. Most species are found in warm, open environments however, and the number of species decreases rapidly at higher latitudes. Asilids are capable flyers and seldom caught in traps.

EMPIDIDAE (dance flies) - Adults of this family are small to medium-sized, slender flies. They are mostly predacious on smaller insects, which they capture in much the same way as do their larger relatives, the asilids. Empidids are best known for the elaborate courtship behaviour of some species, wherein males present females with a prey item, or in specialized groups, a prey substitute (a ball of silk or froth produced by the male), to avoid being eaten by the female prior to mating. The larvae of most empidid species are predacious, and are found in a variety of aquatic and terrestrial habitats including soil, decaying vegetation and dung. The Empididae are a large family, well represented in temperate and northern regions.

DOLICHOPODIDAE (long-legged flies) - Closely related to the Empididae, the adults and larvae of this large family are mostly predacious and occur in varied habitats. Adults are small to medium-sized, and generally bright metallic green. In contrast to the empidids which catch prey on the wing and suck their captives dry using a piercing proboscis, dolichopodids hunt on foot and rasp their prey apart with tiny "teeth" on the inside edges of a pad-like proboscis.

LONCHOPTERIDAE (spear-winged flies) - Lonchopterids are small, slender, light-colored flies with an unusually tapered, pointed wing. Only 4 species of this small family are recorded from North America, though individuals are fairly common in damp environments. Little is known about their habits, except that the flattened larvae are recorded from leaf litter and adults apparently are nectar feeders.

PHORIDAE - Adults of most phorids are easily recognized by their tiny size, humpbacked appearance and enlarged hind femora. They are common in most habitats, though are often unnoticed because of their size and rather furtive habits. Larvae are remarkably varied in their food requirements; some species are parasites of invertebrates, some live in ant or termite nests, while others feed in dung, fungi, or decaying plant or animal matter. One Old World species has been termed the "coffin fly" because of its ability to locate and feed on buried corpses.

SYRPHIDAE (hover flies) - Hover flies are among the most conspicuous of flies, common in most habitats and easily recognized by their yellow and black patterned bodies and ability to hover in flight.

Some species, including several taken at Wagner and Bistcho, mimic different wasps and bees in appearance. Because of this mimicry, they are apparently avoided by most predators of non-stinging insects. Larvae of many syrphid species are predators of other insects, particularly aphids, though their degree of beneficial impact has not been evaluated.

PIPUNCULIDAE (big-headed flies) -Adults of this family are rather small, uncommon flies, characterized by an unusually large head almost entirely occupied by the compound eyes. Like syrphids, pipunculids are excellent fliers and have mastered the art of hovering. Larvae develop as internal parasites of Homoptera, especially leafhoppers and planthoppers.

MICROPEZIDAE (stilt-legged flies) - These are slender-bodied flies of moderate size, with long legs and narrow wings. Adults frequent damp, vegetated areas where they prey on other insects. Larvae develop in decaying plant material or dung. The Micropezidae are a small, mostly tropical family, with fewer than 30 species in North America.

DRYOMYZIDAE - This is a small family of medium-sized, yellowish or brownish flies. Adults are relatively uncommon, and generally inhabit damp woods or shorelines. Larvae develop in varied types of decaying organic matter, including seaweed, plant and animal remains and dung.

SCIOMYZIDAE - Sciomyzids are similar in size, coloration and appearance to the Dryomyzidae, except they usually have elongate, protruding antennae. Larvae are highly specialized in their feeding habits, with almost all species of this moderate-sized family feeding on aquatic or terrestrial snails. Eggs are laid either on vegetation or directly on the shell of a snail, depending on the species. The larvae of some sciomyzids feed only on dead snails (presumably the primitive condition for the family), others complete their entire development on a single living snail (which is killed when larval development is complete), while still others are predatory and during their larval life feed on a succession of snails..

SEPSIDAE - These smallish, slender flies have a characteristic constriction between the second and third segments of the abdomen and (in most species) a dark spot on each wing anterior to the wing tip. Larvae feed on decaying organic matter, including dung, sometimes reaching high numbers in manure piles. The legs of adult males of some species are modified and spined, presumably for grasping the female while mating.

HELEOMYZIDAE - Adults are generally similar in appearance and coloration to those of the Dryomyzidae and Sciomyzidae. Larvae develop in decaying organic matter in a variety of habitats. Adults generally frequent shaded, vegetated areas, where they may be relatively common flies. More than 100 species are recorded from North America.

SPHAEROCERIDAE (small dung flies) - Sphaerocerids are tiny, common and ubiquitous flies. They are rarely noticed except for the manure and dung-infesting species, which can build up high populations wherever livestock are kept. Besides dung, larvae are also recorded from other kinds of decaying organic matter. Adults are unusual in possessing a broad, short first tarsal segment on the hind leg, the significance of which is unknown. The Sphaeroceridae of North America are not well known, and many undescribed species exist.

EPHYDRIDAE (shore flies) - These are relatively small flies with a rounded, protruding face and haired arista. Adults are most commonly seen along seashores and marshes, where they feed on algae and bacteria. High populations of larvae frequently develop in such habitats, living on micro-organisms in the water or in wet areas near water. Larvae and adults display a variety of feeding habits; for example, adults of one genus have modified, grasping front legs for capturing and subduing prey.

CHLOROPIDAE (grass flies) - This is another group of small, common flies. Larvae of most species feed on living plant tissue (e.g., frit flies are a serious pest of cereal crops), while others are predacious or saprophagous.. The thorax of adult chloropids is usually brightly striped in yellow and black, and the ocellar triangle on top of the head is conspicuously enlarged and shiny. Adults are most common in grassy or shrubby areas, and those of most species visit flowers for nectar.

SCATHOPHAGIDAE (dung flies) - This is a moderate-sized family of medium to large flies, classified by some authorities as a subfamily of the Anthomyiidae or Muscidae. Adults are robust, rather elongate flies, often very hairy and bristled. The feeding habits of larvae include leaf-mining and other forms of plant-feeding, though those of the most common species live in dung. Adults of the dung-inhabiting species not only lay eggs on dung but are also preda-

cious on other insects attracted to dung. The family is well represented in northern regions.

ANTHOMYIIDAE - Closely related and similar in appearance to members of the Muscidae are the anthomyiids. These are a large family of ubiquitous flies. Adults are mostly nectar-feeders, while larvae exhibit a wide range of feeding habits: most feed on dead or living plant material, some in dung, and few are associated with aquatic or semi-aquatic plants. The larvae of some species are important agricultural pests, burrowing into and destroying roots and stems of vegetable or cereal crops. About 600 species are recorded from North America, with many temperate to northern in distribution.

MUSCIDAE - The well-known house fly belongs to this large family of mostly medium-sized flies. Many resemble house flies, with robust bodies and drab coloration. Larval feeding habits are varied, though most develop in decaying plant or animal matter; human garbage, for example, is an ideal source for some species. Among the more important pest species, besides the house fly, are the face fly (which bother domestic animals by feeding on secretions around the eye) and horn and stable flies (both sexes of which are blood-feeders of warm-blooded vertebrates).

CALLIPHORIDAE (blow flies) - Like some muscids, a number of species of this family live in close association with man. In particular are the common greenbottle and bluebottle flies, which develop as larvae in many kinds of dead or decaying organic matter. Most calliphorids are easily distinguished from muscids by their larger size and broad, metallic-colored abdomen. A serious pest in the southern United States is the primary screwworm - females of this species lay eggs on open wounds of warm-blooded animals, including domestic animals, and the larvae feed on the living flesh. A rather rare, calliphorid recorded from Wagner has larvae which are parasites of land snails, and adults which are confusingly muscid-like in appearance.

SARCOPHAGIDAE (flesh flies) - Adults of this large family are markedly varied in size and appearance. Most are heavily bristled with the thorax striped in black and grey and the abdomen checkered in black and grey. Sarcophagid larvae have diversified into many habitats and use a number of food sources. Many are internal parasites of other insects, killing their host just before completing development (as do tachinids), while others live in dung or other forms of decaying organic matter. The larvae of certain muscids, calliphorids and sarcophagids are among the first insects to infest fresh animal remains (including human corpses). The known life histories of these species are sometimes used by forensic entomologists to estimate the date of death of human bodies found in exposed situations.

TACHINIDAE - The Tachinidae are a very large and diverse family of flies, which during their larval stage are internal parasites of other arthropods (killing their host before pupating). Adults are considerably varied in form, though most are moderately large and very bristly. The family is one of the largest in North America, but the greatest species diversity is in the Old and New World tropics.

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ANNOTATED LIST OF THE BUTTERFLIES (LEPIDOPTERA) OF BISTCHO LAKE

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The following is an annotated list of the butterflies collected at Bistcho Lake from 13 -22 June, 1987. Because of the short duration of the expedition we did not expect to aquire all the butterfly species likely to occur in the region. The expected fauna over the entire season is 37 species of which 12 are treated in this list. Information on distribution and larval food plants was obtained from Klots (1960), Hooper (1973), Howe (1975), Scott (1986), Tilden and Smith (1986) and Ferris (1988). The food plants include species found within the range of the butterflies; several of these plants do not occur in Alberta.

Family Hesperiidae

Pyrgus centaureae freija (Warren). **Grizzled skipper.**

This Holarctic species has 2 subspecies in Alberta, *P. c. loki* Evans in the Rocky Mountains while *P. c.* freija is North American subarctic in distribution. The latter is found commonly throughout the boreal forest of Alberta. In Europe, the Grizzled Skipper feeds on *Rubus chamaemorus* (Cloudberry), but its diet is unreported for North America.

Carterocephalus palaemon mandan (Edwards). **Arctic skipper.**

This Holarctic species, represented in North America by a single subspecies, is primarily boreal in distribution. In Alberta the Arctic Skipper is found throughout the province along hedgerows and in clearings of *Populus* (Poplar) and mixed forests. The larvae feed generally on grasses.

Family Papilionidae

Papilio glaucus canadensis Rothschild & Jordan. **Eastern tiger swallowtail.**

This is a Nearctic species found throughout eastern North America. The subspecies *canadensis*, common in the boreal forest of Canada and the United States, is found throughout Alberta in or near *Populus* stands. The most common food plant is *Populus*, but the larvae are also known to feed on *Prunus* (Cherry), *Betula* (Birch), *Sorbus* (Mountain Ash), *Salix* (Willow), *Liriodendron* (Tulip tree), *Fraxinus* (Ash), *Tilia* (Basswood) and *Malus* (Apple).

Family Pieridae

Artogeia napi (Linnaeus). **Mustard white.**

This Holarctic species is found in the boreal zone of North America south through the Rocky Mountains to Arizona and New Mexico. Its subspecific status in Alberta has not been established. The Mustard White flies usually along shaded edges and in openings in mixed forests. Larval food plants are members of the mustard family (Cruciferae), especially *Dentaria* (Milkmaids).

Colias alexandra Edwards. **Queen Alexandra sulphur.**

This is a western North American species. Three subspecies, *C. a. alexandra*, *C. a. astraea* Edwards and *C. a. christina* are reported from Alberta. Because of the difficulty in separating *C. a. astraea* from *C. a. christina* no subspecific determination was made for the Bistcho Lake material. This butterfly is common in open meadows and old logged areas within the boreal forest and mountain region. Food plants include members of the pea family (Leguminosae) such as *Astragalus* (Locoweed), *Thermopsis* (Golden Bean), *Lathyrus* (Vetchling) and *Hedysarum* (Sweet Vetch).

Colias canadensis Ferris. **Canada sulphur.**

The Canada sulphur is a butterfly of the boreal forest of Alaska, the Yukon, British Columbia and Alberta. In Alberta it is known from 3 localities in the northwestern corner of the province and 1 locality in the Rocky Mountains. The larval foodplant is not know. although Ferns (1988) assumes it to be members of the Leguminosae. It is found in willow bogs and open areas where *Hedysarum* spp. blooms.

Family Lycaenidae

Everes amyntula albrighti Clench. **Western tailed blue.**

This Nearctic species is found throughout western North America. The subspecies *E. a. albrighti* is found in Alaska, western Canada and south to Montana and Minnesota. It is common throughout Alberta in open Poplar and mixed forest, meadows and prairie. Larval food plants include *Lathyrus* (Vetchling), *Astragalus* (Milk Vetch) and *Vicia* (Vetch).

Celastrina landon lucia (Kirby). **Spring azure.**

The spring azure is found throughout North America south of the tundra and south through Central America to Panama. The subspecies *lucia* is found throughout Alaska and Canada south of the tundra to the northern United States. It occurs commonly throughout Alberta in open poplar and mixed forests, hedgerows and brush. Larval food plants include *Cornus* (Dogwood), *Spiraea* (Meadowsweet), *Vaccinium* (Blueberry) among many others.

Glaucopsyche lygdamus couperi Grote. **Silvery blue.**

This species is found throughout North America south of the tundra, except for the hot humid belt from Kansas and Missouri south to Texas and Florida. The subspecies *couperi* is found throughout Canada and Alaska south to Minnesota, Michigan and Wisconsin. It is common throughout Alberta in forest edges, brush, meadows and prairie. It feeds on *Lathyrus* (Vetchling), *Vicia* (Vetch), *Astragalus* (Locoweed), *Lupinus* (Lupine) and other legumes.

Family Nymphalidae

Polygonia faunus rustica (Edwards). **Green comma.**

The green comma is a Nearctic species found throughout most of North America south of the tundra to northern Georgia, Iowa and central California. The subspecies *rustica* occurs from British Columbia and Alberta south to northern California. It is found throughout Alberta, except the prairies, in White Spruce and mixed forests. Food plants include *Salix* (Willow), *Alnus* (Alder), *Ribes* (Gooseberry) and *Betula* (Birch).

Vanessa atalanta rubria (Fruhstorfer). **Red admiral.**

The red admiral is another Holarctic species. The subspecies *rubra* collected at Bistcho occurs throughout North America south of the tundra to Guatemala in Central America. In the northern part of its range, including Alberta, it is probably a migrant. It is found throughout Alberta in open woodlots, stream edges, shrubby fields and disturbed areas wherever its food plant *Urtica* (Nettle) is found.

Proclossiana freija freija (Thunberg). **Freija fritillary.**

This Holarctic species is found in North America throughout the tundra and boreal forest, south in the Rocky Mountains to northern New Mexico. The nominate subspecies *P. f. freija* occurs across subarctic Eurasia into Alaska, south to Washington and east to Manitoba. It is found throughout Alberta, except in the prairies, in open White Spruce and pine forests, dryer bogs and adjacent meadows. The food plant is *Vaccinium caespitosum* (Dwarf Bilberry).

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THE FISH AND HERPETOFAUNA OF THE BISTCHO LAKE AREA

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INTRODUCTION

Prior to 1987, the acquisition of lower vertebrate specimens (fish, amphibians, and reptiles) played a minor role in the growth of the natural history collections at the Provincial Museum of Alberta. Due in part to the remoteness of the Bistcho Lake area, the collection of a small but representative sample of the fish and hepetofauna was considered appropriate on a trip to this region. Seven species of fish (99 specimens) and 1 species of amphibian (8 specimens) were collected in and around the eastern portion of Bistcho Lake in June 1987. An additional species, the Lake Whitefish (*Coregonis clupeaformis*) was observed and captured but no specimens were retained. No reptiles were encountered.

Few surveys of the lower vertebrate fauna have been conducted in the Bistcho Lake area of northwest Alberta. Paetz and Nelson (1970) found 9 species of fish in the lake and the associated Petitot drainage system. Brilling (1983) also reported 9 fish species but 3 were different from those recorded by Paetz and Nelson. O'Neill (1969) encountered 6 species, primarily those of interest to the commercial fishery. Griffiths and Ferster (1974) reported 6 species from the Petitot River, including the Arctic Grayling (*Thymallus arcticus*), a species which has never been reported from the lake. A provisional list of the fish found in the Petitot drainage system is given in Table 1.

Two species of amphibian, the Wood Frog (*Rana sylvatica*) and the Striped Chorus Frog (*Pseudacris triseriata*) have been reported from this area (Cook 1984, Stebbins 1966). No reptiles have been reported from the extreme northwest corner of the province although the range of the Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) reaches its northern limit just south and east of the Bistcho Lake area (Conant 1958, Stebbins 1966, Cook 1984).

ORIGIN AND POSTGLACIAL DISPERSAL OF BISTCHO LAKE FISH

Approximately 60 species of freshwater fish are known to occur in northwestern Canada and Alaska (McPhail and Lindsey 1970). In Alberta, 45 native species and 4 introduced species have been reported (Paetz and Nelson 1970). When compared with the over 170 species found in the much smaller Great Lakes region, the fish fauna of the Canadian northwest is quite depauperate.

Patterns of species dispersal and present fish distributions can in large part be explained by examining geological evidence of the movement of ice sheets during the Pleistocene. As the ice mass of the Wisconsin glaciation retreated to the northeast some 10,000 to 15,000 years ago, fish which had survived in ice-free refuges at the periphery of the ice sheet began to move into previously glaciated areas via newly formed lakes and rivers. The three main refugia from which most northwestern Canadian fish originated were: the Bering refuge, north and west of Alaska; the Pacific refuge which encompassed much of the northwestern United States west of the Rocky Mountains; and the Mississippi refuge which included the upper Missouri, upper Mississippi and Ohio River valleys. Although many species entered northwestern Canada from more than 1 refuge, most of the fish currently found in the upper Mackenzie River system are of Mississippi origin. Arctic Grayling, Northern Pike, and Ninespine Stickleback probably survived glaciation in both the Bering and Mississippi refuges. The Longnose Sucker, Burbot, and Slimy Sculpin are believed to have entered the Bistcho Lake area from the Pacific, Bering and Mississippi refuges (McPhail and Lindsey 1970).

PHYSIOGRAPHY OF THE LAKE

Bistcho is a large, shallow, eutrophic lake in the Liard River basin of northwestern Alberta. It is part

Table 1. Fish species reported from the Petitot River system in Alberta.

Fish	Reference
Lake Whitefish (*Coregonus clupeaformis*)	1, 4, 5
Cisco (*Coregonus artedii*)	1, 4
Arctic Grayling (*Thymallus arcticus*)	2
Northern Pike (*Esox lucius*)	1, 2, 4, 5
Lake Chub (*Couesuis plumbeus*)	1
Emerald Shiner (*Notropis atherinoides*)	3, 5
Spottail Shiner (*Notrpis hudsonius*)	5, 6
White Sucker (*Catostomus commersoni*)	1, 2, 4, 5
Longnose Sucker (*Catostomus catostomus*)	1, 2, 4
Burbot (*Lota lota*)	2, 5
Ninespine Stickleback (*Pungitius pungitius*)	1, 5
Trout-Perch (*Percopsis omiscomaycus*)	1
Walleye (*Stizostedion vitreum*)	1, 2, 3, 4, 5, 6
Slimy Sculpin (*Cottus cognatus*)	5

1 Brilling (1983); 2 Griffiths and Ferster (1974); 3 McPhail and Lindsey (1970); 4 O'Neill (1969); 5 Paetz and Nelson (1970); 6 Scott and Crossman (1973)

of the Petitot River system (Fig. 1) which drains westward out of the province to the Liard River and ultimately to the Beaufort Sea via the MacKenzie River. The lake has a surface area of approximately 375 km^2 and a total shoreline of just under 165 km (O'Neill 1969). The average depth is approximately 3 m and the maximum depth is reported to be 7 m (Paetz and Nelson 1970). The depth contours of the lake, as reported by O'Neill (1969), are shown in Figure 2.

Bistcho Lake is characterized by an extensive littoral region which can under appropriate conditions become completely choked with submergent, and in some cases, emergent, vegetation (J. Halverson, pers. comm.) The dominant forms of emergent vegetation are sedges (*Carex* spp.) and bulrushes (*Scirpus* spp.). However, no detailed study of the submergent vegetation was conducted during our study.

Water chemistry analyses of samples taken by O'Neill in August of 1969 are shown in Table 2. Although we took no quantitative measurements, the turbidity of the water (the opaqueness produced by suspended particles) was relatively high throughout the study period. The apparent color of the water (the perceived color when factors such as sky reflection and the interplay of light on suspended particles is taken into account) was brownish or grey-brown in all areas examined. Additional details of lake characteristics are found elsewhere in this volume (see contribution by Hastings and Ellis).

COLLECTION METHODS

We captured most of the fish by beach seining. A beach seine is a fine mesh net with a weighted cord along the bottom and floating cord along the top, thus enabling it to hang vertically in the water. Hand and foot loops are attached to the corners of the net. With one person at each end, the net is pulled through a stretch of shallow water and then up onto the shore where any trapped fish can be examined (Fig. 3). Seine hauls approximately 10 m in length were run using a 5.0 m x 2.5 m net. We took samples over a variety of substrates along the shoreline of the eastern portion of the lake. Several of the larger sport fish were caught by hook and line in a shallow, weedy bay located east of the base camp (Fig. 4). All collecting was done during daylight hours. Specimens were placed initially in 35% ethanol, fixed in 10% formalin, and preserved in 70% ethanol. All of the amphibians were captured by hand, placed in 35% ethanol, fixed in 10% formalin, and preserved in 65% ethanol. Nomenclature for fishes follows that of Scott and Crossman (1973) and for amphibians that of Cook (1984).

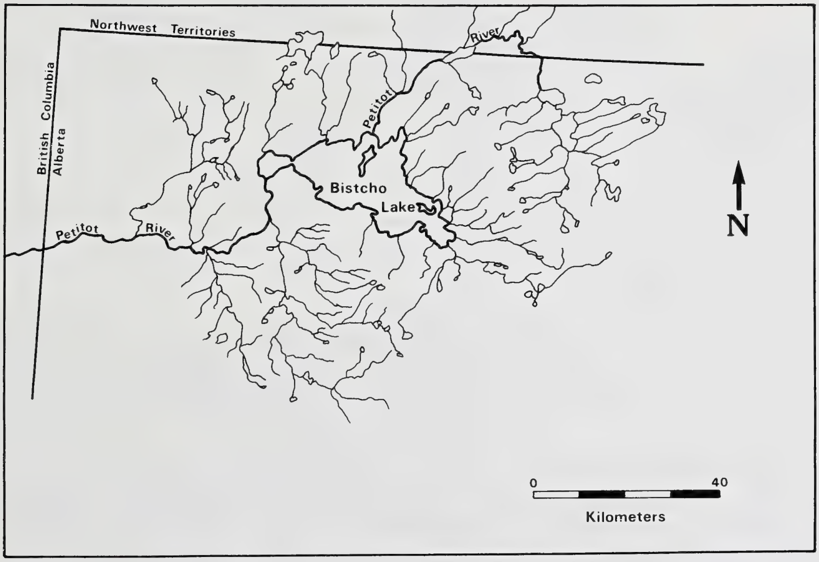

Figure 1. Bistcho Lake in the Petitot River drainage system in Alberta.

Figure 2. Depth contours of Bistcho Lake.

Table 2. Bistcho Lake water chemistry analyses, August 1969.[1]

	Sample No. 1	2	3
Variable			
Date	3/08/69	5/08/69	12/08/69
Depth (m)	4.57	4.57	
Temperature (^{o}C)	18	17	3.05
Dissolved Oxygen (mg O_2l^{-1})	7	7	15.5
Total Alkalinity (ppm)	65	65	8
Calcium Hardness (ppm)	60	50	48
Total Hardness (ppm)	95	90	53
pH	7.1	7.1	93

1. Adapted from O'Niell (1969).

FISH

Lake Whitefish (*Coregonis clupeaformis*) - no specimens retained

Large numbers of this bottom dwelling species were observed feeding on insects on the surface of the lake at dusk. One adult specimen was captured in an early evening seine haul and several individuals were caught by hook and line but none was retained.

Recent studies suggest that *Coregonis clupeaformis* is actually a complex of several races of Lake Whitefish which differ in a number of physical and behavioral characteristics and may constitute more than 1 species (McPhail and Lindsey 1970).

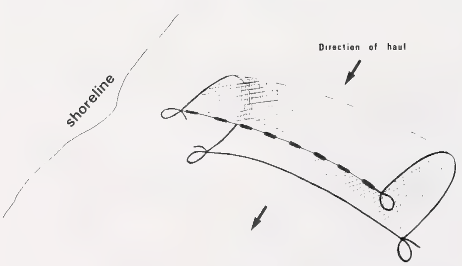

Figure 3. Representation of seine net haul.

Hybridization between Lake Whitefish and its congener, Cisco (*Coregonus artedii*) is known to occur where the species are sympatric (Paetz and Nelson 1970, Scott and Crossman 1973). Our collecting did not produce any Cisco but they were more plentiful than Lake Whitefish in a survey of Bistcho Lake conducted in July of 1983 (Brilling 1983). Commercial fishermen also report Cisco from the lake.

Northern Pike (*Esox lucius*) - 40 specimens retained

We encountered this common species in all areas sampled. Beach seining produced pike in: sparsely vegetated, rocky bottomed areas; sandy bottomed areas with little or no vegetation; and shallow water underlain by several feet of detritus. Thirty-six of the 40 individuals acquired were fry, 25-40 mm in length. Larger individuals up to 8 kg were caught by hook and line in deeper zones (2-3 m of water) but because of storage and transport difficulties were not kept.

Northern Pike spawn in early spring, often before the ice leaves the lake. In some areas, fry can grow to 280 mm in their first year (Paetz and Nelson 1970). Commercial fishermen on Bistcho Lake have reported catching adults up to 20 kg (44 lb.) in gill nets beneath the ice (J. Baitmann pers. comm.).

Spottail Shiner (*Notropis hudsonius*) - 28 specimens retained

This species was common in shallow water (0-1 m) over rocky substrate with little or no emergent vegetation. On several occasions, schools of 50-60 in-

Figure 4. Fish and amphibian collecting sites at Bistcho Lake.

dividuals were caught in a single 10 m seine haul. Two of the 28 specimens retained were immature (28 mm fork length), the other 26 were of adult size (average fork length 76 mm). Sexual maturity generally occurs when the fish reach 68 mm in total length (McPhail and Lindsey 1970).

It is interesting to note that Brilling (1983) did not report any Spottail Shiners in his July 1983 survey of Bistcho Lake and McPhail & Lindsey (1970) found no records of this species from the upper Liard River system.

White Sucker (*Catostomus commersoni*) - 7 specimens retained

All of the specimens collected were immature (average fork length 65 mm) seined in shallow water (0.25 m - 1.0 m) over a rocky substrate with no emergent vegetation. Several suckers were seined together with large schools of Spottail Shiners.

A congener of the White Sucker, the Longnose Sucker (*Catastomus catostomus*) has also been reported from Bistcho Lake (Table 1) although none was encountered on our expedition.

Ninespine Stickleback (*Pungitius pungitius*) - 3 specimens retained

We collected three adult specimens (average fork length 47 mm) in shallow water over rocky substrate in areas with very sparse sedge (*Carex* spp.) growth. Typically, this species is associated with heavy rooted aquatic vegetation (McPhail and Lindsey 1970), but seining in these areas is difficult. Brilling (1983) found Ninespine Sticklebacks to be abundant although localized within the lake.

Trout-Perch (*Percopsis omiscomaycus*) - 17 specimens retained

Our collecting suggests that this species is not uncommon in Bistcho Lake although Paetz and Nelson (1970) and McPhail and Lindsey (1970) have no records of this species either in the lake or in the upper Liard River drainage. Brilling (1983), however, collected a substantial number of Trout-Perch from an area around Gull Island in the northwest region of the lake.

All 17 specimens were caught by beach seining in shallow water with rocky substrate and little or no

emergent vegetation. The average fork length for the specimens is 78 mm (range 64-84 mm) suggesting that they are all adults.

Trout-Perch exhibit a marked inshore movement at night and are rarely acquired by beach seining during the daytime (McPhail and Lindsey 1970, Paetz and Nelson 1970). Interestingly, all of our specimens were collected between 0090 and 1200 on 20 June.

Walleye (*Stizostedion vitreum*) - 2 specimens retained

This species was common in deeper regions of the areas sampled. The two specimens we collected were caught by hook and line in 2-3 m of water with thick submergent vegetation. These individuals, both measuring approximately 300 mm in length, were the smallest Walleye noted during the expedition. The individuals most commonly observed were in the 1-2 kg range. Although spawning occurs in early spring, no young of the year were collected by beach seining.

Slimy Sculpin (*Cottus cognatus*) - 2 specimens retained

We found this species in shallow, sparsely vegetated areas with rocky substrates. Previously, only Paetz and Nelson (1970) have reported the Slimy Sculpin from the Bistcho Lake. This species, which typically seeks shelter under rocks and boulders, can easily be missed when surveys are conducted using gill or seine nets. A more effective collection method involves searching under rocks and collecting any exposed Sculpins by hand or with a dip net. Not surprisingly, unless a special effort is made to find this species, population sizes are often underestimated (W. Roberts pers. comm.).

Maximum lengths reported for this species from throughout North America range from 109 mm (Scott and Crossman 1973) to 120 mm (McPhail and Lindsey 1970). The specimens we collected measured 54 mm and 55 mm in total length. Richardson (1836) reported some individuals from Great Bear Lake which were only 2.5 inches (60 mm) in length but already sexually mature. Unfortunately, little is known about the growth and development of the Slimy Sculpin in northern Canada; therefore it is uncertain whether the 2 specimens collected are adult or immature.

AMPHIBIANS

Wood Frog (*Rana sylvatica*) - 8 specimens retained

This species was not abundant but was encountered occasionally in wet grassy areas with sparse willow (*Salix* sp.) growth along some of the small rivers flowing into the eastern end of the lake (Fig. 4). In the northern parts of the range, breeding can be delayed until early June, but no Wood Frogs (or any other frogs) were heard calling during the study period.

The Wood Frog exists farther north in North America than any other amphibian, generally reaching the treeline throughout northern Canada (Cook 1984). The only other amphibian which could be expected in the Bistcho Lake area is the Striped Chorus Frog (*Pseudacris triseriata*) but none was encountered on this expedition.

Two color phases of the Wood Frog are known to exist. One is distinguished by a light, medial dorsal stripe extending the full length of the back. The alternate phase has no dorsal stripe. Of the 8 specimens collected on this expedition, two had the medial dorsal stripe and six did not. This stripe is more common in western populations of this species however no subspecies are currently recognized (Cook 1984).

DISCUSSION

The 8 species of fish and 1 species of amphibian encountered on this expedition account for only 50 percent of the 16 lower vertebrate species reported to occur in the Bistcho Lake area (Table 1). A number of factors, including collecting methods, equipment, and the variety of habitats sampled, undoubtedly influenced the numbers and diversity of specimens encountered during this and other studies.

As the Bistcho Lake expedition marked the first attempt at fish collecting undertaken by the Provincial Museum, it was a testing ground for new equipment and methods. Except for a small number of individuals taken by hook and line, beach seining was the only method used to collect fish. This technique has limitations which make sampling in many areas difficult if not impossible. Deep, open water regions, areas with dense aquatic vegetation, and those with irregular bottoms or excessive subsurface debris are unsuitable for beach seining. Because many fish prefer these kinds of microhabitats, it is not surprising

that a number of species cannot readily be captured by this method.

No special equipment or techniques were used to collect amphibians. All specimens were hand caught by various members of the expedition whenever a specimen was encountered. Although as mentioned previously, no calling was heard during the study period, collecting at night with a flashlight may have produced more specimens.

The size of the lake and the problems of access to distant regions also had a considerable influence on the variety of areas sampled and therefore on the diversity of species encountered. All fish collecting was, of necessity, restricted to several shallow, littoral regions in the easternmost portion of the lake (Fig. 4). Surveys conducted by Brilling (1983) and Griffiths and Fester (1974) around Kirkness Island, Gull Island, and in or near the Petitot River (about 15-20 km west of the areas we sampled), yielded a number of species different from those we encountered. The Arctic Grayling, for example, was found only in the faster moving waters of the Petitot River over a substrate of boulders, rubble, and some gravel (Griffiths and Fester 1974). The only record of the Lake Chub was that made by Brilling (1983) from near Gull Island in the northwest portion of the lake (Fig. 4).

Several fish which we observed and collected were not mentioned in species accounts of other authors. The secretive nature of the Slimy Sculpin, as discussed earlier, may account for the small number of individuals we encountered (2) and the absence of this species from Brillings' 1983 survey. The surveys of Griffiths and Ferster (1974) and O'Neill (1969) appear to have concentrated on species of importance to the commercial and sport fishery. Economically important fish, which tend to be relatively large, are typically captured by equipment and techniques (e.g. large mesh gill nets) which are not effective in the collection of smaller species. This may explain why Spottail Shiners and Trout-Perch, which we determined to be quite common, were not reported by other authors.

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BIRDS OF THE BISTCHO LAKE REGION

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Regional avifaunal surveys are no longer a fundamental component of the ornithological literature in North America. This is surprising considering the current emphasis on mapping bird breeding distributions through atlassing projects. Despite this trend, in remote areas in North America, there is still a need for collection of basic natural history information. Documenting bird distributions through acquisition of specimens and storage in a museum provides permanent baseline information for use in a variety of research projects including atlassing. In this chapter I provide an annotated list of birds collected and observed in June of 1987 near the eastern part of Bistcho Lake in northwestern Alberta.

Previous ornithological work in the immediate area of Bistcho Lake has been restricted to Schaafsma's (1975) studies of nesting Bald Eagles (*Haliaeetus leucocephalus*). Gunn *et al.* (1975) conducted avifaunal surveys along the proposed route of the Arctic Gas Pipeline including one in the vicinity of Zama, 60 km south of Bistcho Lake. The most extensive work in the area is that of Höhn and Burns (1975, 1976) who studied the mammals and birds of the Caribou Mountains, 200 km southeast of Bistcho Lake.

METHODS

Study Area

Bistcho Lake forms part of the Petitot River drainage which flows into the Mackenzie River. It lies about 20 km from the Northwest Territories and 55 km from British Columbia. The lake and surrounding area provide a diversity of habitats for birds. Details on the vegetation of the area are provided elsewhere in this volume (see Hastings and Ellis). The majority of collecting time was spent in mixed aspen (*Populus tremuloides*)-Black Spruce (*Picea mariana*) woods which rapidly degenerated to black spruce bog away from the lake. Other habitats were: (1) sedge marshes mixed with willow and birch thickets along rivers and in shallow bays; (2) open water; (3) Jack Pine (*Pinus banksiana*) forest; (4) narrow strips of grassland near the formerly settled areas of the Bistcho Lake Indian Reserve; and (5) scrubby willow, alder brush near a cleared airstrip.

A map giving collecting sites is shown in Fig. 1. I refer regularly in the annotated listings to two sites - the lodge on the northeastern edge of the lake and the Bistcho Lake Indian Reserve on the eastern shore.

Collections

Although the extent and distribution of habitat types were not known until after the trip, attempts were made to access as many as possible. Movement away from the lake was restricted to cutlines by the thickness of the bush. In all about 45 man-days were spent surveying the area.

Species Status

In preparing the annotated list, besides recording the presence of a species, an effort was made to rank abundance to one of the following levels: abundant, common, fairly common, uncommon, and rare. These are arbitrary but loosely defined as follows: *abundant* - seen in large numbers in a variety of habitats every day; *common* - seen in large numbers but less widespread and not every day; *fairly common* - seen regularly but not in great numbers; *uncommon* - seen only on a few occasions or if consistently, in low numbers at one site; *rare* - seen only once or twice. Obviously, the size, taxonomic group, and "detectibility" of each species will affect its abundance on this scale. Additional comments are provided in the discussion section for those species marked with an asterisk.

RESULTS

Species Accounts

Common Loon (*Gavia immer*) - specimens 0; status common: Pairs seen regularly in deeper water, calls heard daily.

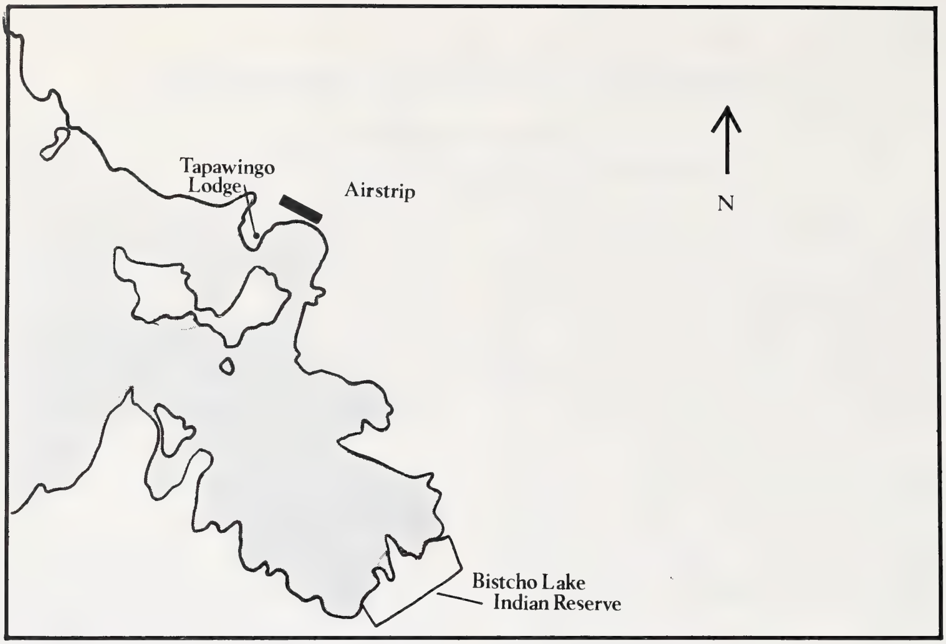

Figure 1. Collecting locations on the eastern edge of Bistcho Lake, Alberta.

Red-necked Grebe (*Podiceps grisegena*) - specimens 2; status common: Specimens acquired in a shallow bay west of lodge, observed daily in bays along the northeastern edge of the lake.

***Trumpeter Swan** (*Cygnus buccinator*) - specimens 0; status rare: 3 birds noted 17 June, two on 18 June flying in the vicinity of the Bistcho Lake Indian Reserve. The identification was confirmed by vocalizations.

Canada Goose (*Branta canadensis-*) - specimens 0; status rare: 4 birds seen 19 June at the Bistcho Lake Indian Reserve.

Green-winged Teal (*Anas crecca*) - specimens 2; status abundant: most common duck, seen daily throughout shallow areas at the eastern end of the lake. Nests with eggs and females with young were observed.

Mallard (*Anas platyrhynchos*) - specimens 3; status abundant: seen daily in large numbers in shallow bays and along rivers.

Pintail (*Anas acuta*) - specimens 0; status fairly common: seen infrequently in bays to the west and southeast of the lodge and near the Bistcho Lake Indian Reserve.

Blue-winged Teal (*Anas discors*) - specimens 1; status common: seen throughout eastern end of lake, nests with eggs and females with young observed in sedges in bays east of the lodge.

***Gadwall** (*Anas strepera*) - specimens 0; status uncommon: seen occasionally in a shallow bay west of the lodge.

American Wigeon (*Anas americana*) - specimens 1; status abundant: noted daily in shallower water particularly along rivers flowing into the eastern edge of the lake.

Ring-necked Duck (*Aythya collaris*) - specimens 0; status fairly common: pairs seen along rivers and in the open lake.

Lesser Scaup (*Aythya affinis*) - specimens 3; status common: pairs seen along rivers and in the open lake.

White-winged Scoter (*Melanitta fusca*) - specimens 4; status fairly common: pairs and small flocks of 8-10 individuals seen regularly in the open lake.

Common Goldeneye (*Bucephala clangula*) - specimens 0; status uncommon: seen occasionally along rivers and in the open lake.

Bufflehead (*Bucephala albeola*) - specimens 1; status fairly common: pairs seen on the river at the Bistcho Lake Indian Reserve.

Common Merganser (*Mergus merganser*) - specimens 0; status uncommon: individual birds noted occasionally, one pair seen near the southeast end of the lake.

Red-breasted Merganser (*Mergus serrator*) - specimens 0; status rare: one individual seen in the open lake on 12 June.

*__Bald Eagle__ (*Haliaeetus leucocephalus*) - specimens 0; status common: seen daily, one nest with 2 young south of the lodge, other pairs observed in vicinity of the lodge.

Sharp-shinned Hawk (*Accipiter striatus*) - specimens 0; status rare: one individual seen 15 June being pursued by Rusty Blackbirds (*Euphagus carolinus*).

Goshawk (*Accipiter gentilis*) - specimens 0; status rare: one individual noted 18 June in the pine woods on the Bistcho Lake Indian Reserve.

Red-tailed Hawk (*Buteo jamaicensis*) - specimens 0; status uncommon: one bird seen on 2 separate days 18, 19 June near the Bistcho Lake Indian Reserve.

*__Broad-winged Hawk__ (*Buteo platypterus*) - specimens 0; status uncommon: one bird seen in pine forests near the Bistcho Lake Indian Reserve.

Marsh Hawk (*Circus cyaneus*) - specimens 0; status rare: one bird (male) seen 18 June over a sedge marsh at the southeast edge of the lake.

Spruce Grouse (*Dendragapus canadensis*) - specimens 0; status uncommon: one confirmed sighting east of the airstrip, grouse droppings throughout Black Spruce bogs and pine forest.

Ruffed Grouse (*Bonasa umbellus*) - specimens 5; status common: noted throughout aspen woods and in the pine forest.

Sharp-tailed Grouse (*Pediocetes phasianellus*) - specimens 1; status rare: partial remains of one individual found west of the lodge.

Sora (*Porzana carolina*) - specimens 0; status uncommon: a male was heard calling daily over a week long period in a sedge marsh, at the eastern edge of the lake.

Killdeer (*Charadrius vociferus*) - specimens 2; status uncommon: one pair found breeding along the airstrip northeast of the lodge.

Lesser Yellowlegs (*Tringa flavipes*) - specimens 7; status common: flocks of 8-10 individuals in shallow bays throughout the eastern end of the lake. Pairs noted but no nests found.

Solitary Sandpiper (*Tringa solitaria*) - specimens 2; status uncommon: pair found nesting in spruce trees on the edge of the lodge airstrip.

Common Snipe (*Gallinago gallinago*) - specimens 0; status uncommon: a single male seen and heard winnowing over sedge marshes east of the Bistcho Lake Indian Reserve.

Herring Gull (*Larus argentatus*) - specimens 5; status common: throughout eastern end of the lake.

*__Mew Gull__ (*Larus canus*) - specimens 1; status rare: one individual seen 16 June over the lake southeast of the lodge. The bird was with a group of Franklin's Gulls.

*__Franklin's Gull__ (*Larus pipixcan*) - specimens 7; status fairly common: large flocks of Franklin's Gulls were seen on several occasions over the open lake southeast of the lodge. No nesting colony was found.

Bonaparte's Gull (*Larus philadelphia*) - specimens 0; status uncommon: a few individuals seen mixed with the flocks of Franklin's Gulls.

Common Tern (*Sterna hirundo*) - specimens 1; status uncommon: individuals and pairs noted occasionally. No nesting colony was found.

*__Caspian Tern__ (*Sterna caspia*) - specimens 0; status rare: one individual seen on one day flying over the open lake.

Black Tern (*Chilidonias niger*) - specimens 5; status fairly common: seen regularly in two shallow bays east of the lodge. The largest concentration was near the site of the Bistcho Lake Indian Reserve.

Great Horned Owl (*Bubo virginianus*) - specimens 0; status rare: one individual flushed from a Jack Pine on Bistcho Lake Indian Reserve.

Boreal Owl (*Aegolius funereus*) - specimens 0; status rare: one bird heard calling on an unnamed island south of the lodge.

Nighthawk (*Chordeiles minor*) - specimens 1; status fairly common: seen regularly at 3 locations east of the lodge, active throughout the day.

***Yellow-bellied Sapsucker** (*Sphyrapicus varius*) - specimens 5; status common: seen and heard regularly in aspen and mixed woods near the lodge.

***Northern Flicker** (*Colaptes auratus*) - specimens 4; status common: observed frequently in mixed woods throughout the area, absent from pure spruce or Jack Pine stands.

Olive-sided Flycatcher (*Contopus borealis*) - specimens 0; status rare: only one individual noted in the pine woods in the Bistcho Lake Indian Reserve.

Alder Flycatcher (*Empidonax alnorum*) - specimens 6; status common: regular inhabitant of wet areas with willow, birch, and alder shrubs.

Least Flycatcher (*Empidonax minimus*) - specimens 1; status fairly common: observed occasionally but not common in aspen woods near the lodge and the Bistcho Lake Indian Reserve.

Eastern Kingbird (*Tyrannus tyrannus*) - specimens 0; status uncommon: one individual seen over several days in a sedge marsh east of lodge.

Tree Swallow (*Tachycineta bicolor*) - specimens 0; status uncommon: pairs seen along a cut line north of the lodge in a wet spruce bog.

Gray Jay (*Perisoreus canadensis*) - specimens 9; status common: regular throughout the area, fully grown young with adults were being harassed by kinglets, chickadees and blackbirds.

Raven (*Corvus corax*) - specimens 0; status common: observed throughout the area, one nest noted at the west end of the airstrip.

***Boreal Chickadee** (*Parus hudsonicus*) - specimens 8; status abundant: noted in both mixed and coniferous woods in all areas surveyed.

Red-breasted Nuthatch (*Sitta canadensis*) - specimens 2; status common: regular but secretive inhabitant of the mixed and coniferous woods in the region.

Ruby-crowned Kinglet (*Regulus calendula*) - specimens 2; status common: typical inhabitant of spruce forests and bogs throughout the area.

Swainson's Thrush (*Catharus ustulatus*) - specimens 2; status fairly common: not often seen but heard regularly in the aspen woods near the lodge. Calls heard throughout the day including twilight period past midnight.

Hermit Thrush (*Catharus guttatus*) - specimens 0; status rare: one individual seen in the pine woods near the Bistcho Lake Indian Reserve.

Robin (*Turdus migratorius*) - specimens 4; status common: regular throughout area in aspen, mixed woods, and spruce bogs.

Bohemian Waxwing (*Bombycilla garrulus*) - specimens 7; status common: large flocks (20-30 individuals) were seen flycatching over shallow bays in several locations. Most birds foraged from spruce perches but foraging from willows and alders was also common.

***Solitary Vireo** (*Vireo solitarius*) - specimens 6; status fairly common: noted in spruce bogs, mixed woods, and Jack Pine stands.

Red-eyed Vireo (*Vireo olivaceous*) - specimens 7; status common: heard and seen regularly in areas dominated by aspen.

Tennesee Warbler (*Vermivora peregrina*) - specimens 5; status common: seen regularly in willow, alder and aspen along watercourses and inland from the lake.

Yellow Warbler (*Dendroica petechia*) - specimens 3; status fairly common: seen commonly along rivers and in bays east of the lodge in thick willow and alder bushes. Not noted along rivers with reduced shoreline vegetation.

Magnolia Warbler (*Dendroica magnolia*) - specimens 4; status uncommon: most frequently seen in alder and aspen along cutlines north of the airstrip.

Cape May Warbler (*Dendroica tigrina*) - specimens 2; status uncommon: heard frequently but seen only rarely in thick Black Spruce forest in upland areas. Occasionally, Cape May's were seen foraging in deciduous thickets.

Yellow-rumped Warbler (*Dendroica coronata*) - specimens 10; status abundant: numerous in coniferous forests, aspen woods, and willow and alder thickets along rivers throughout the region.

***Blackburnian Warbler** (*Dendroica fusca*) - specimens 0; status rare: one individual seen in a Black Spruce tree on a trail east of the lodge.

Palm Warbler (*Dendroica palmarum*) - specimens 2; status fairly common: noted in alder and willow bushes along streams and rivers leading into the eastern edge of the lake.

Ovenbird (*Seiurus aurocapillus*) - specimens 0; status uncommon: heard infrequently in several areas but seen only once in mixed woods north of the lodge.

Northern Waterthrush (*Seiurus noveboracensis*) - specimens 1; status uncommon: noted on several occasions in thick willows along the lakeshore and on the edge of a creek north of the lodge.

Common Yellowthroat (*Geothlypis trichas*) - specimens 0; status fairly common: vocal but not highly visible in willow, alders and birch thickets near water.

Wilson's Warbler (*Wilsonia pusilla*) - specimens 2; status uncommon: seen locally in thick birch and sedge marsh as well as along a cutline north of the airstrip.

Western Tanager (*Piranga ludoviciana*) - specimens 2; status fairly common: seen in most areas having mixed aspen-spruce woods.

Chipping Sparrow (*Spizella passerina*) - specimens 10; status abundant: common in all habitats surveyed.

Clay-colored Sparrow (*Spizella pallida*) - specimens 0; status rare: at least 1 individual noted in thick sedge and birch bog west of the Bistcho Lake Indian Reserve.

Savanna Sparrow (*Passerculus sandwichensis*) - specimens 3; status uncommon: a pair noted on a grass strip bordering a stream at the Bistcho Lake Indian Reserve. Others seen in a birch and sedge bog west of the reserve.

Fox Sparrow (*Passerella iliaca*) - specimens 0; status uncommon: noted on several occasions east of the lodge in shrubby willows mixed with Black Spruce and some aspen.

Lincoln's Sparrow (*Melospiza lincolnii*) - specimens 6; status fairly common: regularly seen in willow and alder shrubs along the lake or river edges.

Swamp Sparrow (*Melospiza georgiana*) - specimens 3; status fairly common: locally common in thick sedges and in birch and willow marsh near the Bistcho Lake Indian Reserve.

White-throated Sparrow (*Zonotrichia albicollis*) - specimens 1; status uncommon: seen north of the airstrip, heard occasionally elsewhere in wet areas near Black Spruce woods.

Dark-eyed Junco (*Junco hyemalis*) - specimens 10; status abundant: frequently seen in aspen, pine, and mixed aspen-spruce woods throughout the area on the eastern edge of the lake.

Red-winged Blackbird (*Agelaius phoeniceus*) - specimens 15; status common: locally common in marshes at river mouths and along rivers throughout the area.

Rusty Blackbird (*Euphagus carolinus*) - specimens 24; status abundant: generally more numerous than Red-wings in similar habitat.

Common Grackle (*Quiscalus quiscula*) - specimens 3; status uncommon: several pairs nesting west of the lodge on the edge of a shallow bay.

Purple Finch (*Carpodacus purpureus*) - specimens 0; status uncommon: noted occasionally in Black Spruce stands north of the lodge.

Pine Siskin (*Carduelis pinus*) - specimens 1; status uncommon: seen in mixed woods on an unnamed island south of the lodge.

Addendum

High Level

House Sparrow (*Passer domesticus*) - specimens 0; status rare: a single female was observed at the High

Level airport prior to our departure for Bistcho Lake. This bird represents the most northerly record of House Sparrows in Alberta.

DISCUSSION

General

We collected or observed 85 species of birds on or near the eastern edge of Bistcho Lake. A single day survey (16 June 1974) at Zama, 60 km south of Bistcho Lake produced 50 species (Gunn *et al.* 1975). A survey of over 3 summers (1973-1975) in the Caribou Mountains, 200 km southeast of Bistcho Lake generated a list of 88 species for the region (Höhn and Burns 1975, 1976). Although Salt and Salt (1976) list Bistcho Lake as a locality for bird distributions in Alberta, the only published account for the birds of the area is a study of Bald Eagle nesting (Schaafsma 1975).

Only 5 species, Horned Grebe, Western Wood Peewee (*Contopus sordidulus*), Golden-crowned Kinglet (*Regulus satrapa*), Warbling Vireo (*Vireo gilvus*) and a Crossbill (spp. unknown) were observed at Zama but not recorded for the Bistcho area. The low count in the Zama area was likely a function of the single day sample period and the lack of a large water body in the survey area.

Twenty-seven species were collected or observed in our survey that were not recorded in 3 years of field work in the Caribou Mountains. Of these, eleven were observed in the one day survey near Zama (Table 1). The differences in the species surveyed in the Caribou Mountains and the Bistcho area are noteworthy because of the proximity of the sites and their similar latitude. Many species found at Bistcho but not recorded by Höhn and Burns (1974) are typical of aspen parkland and prairie habitats not available in the Caribou Mountains. Higher average elevations in the plateau of these mountains (950 m) creates a more northern habitat which produced some high latitude breeders [Red-throated Loon (*Gavia stellata*), Gray-cheeked Thrush (*Catharus minimus*) and Red-necked (=Northern) Phalarope (*Phalaropus lobatus*)].

Specific

Trumpeter Swan Breeding populations are known from the Peace River district and locally in the Yukon and southwestern Northwest Territories (Godfrey 1986). The area around Bistcho Lake provides ideal nesting habitat but no confirmation of breeding was obtained.

Gadwall This typical prairie puddle duck has been recorded from the Zama Lakes area. The record at Bistcho is the most northerly for the species in the province. No evidence of breeding was found.

Broad-winged Hawk Although more common in eastern Canada, this species is known from central Alberta - Lesser Slave Lake and Swan Hills regions (Salt and Wilk 1976). It has been recorded near Lake Athabasca.

Bald Eagle Schaafsma (1975) recorded 11 active Bald Eagle nests in the Bistcho Lake area. We noted several adult pairs but only one active nest. Anecdotal reports of up to 22 active nests around the lake were heard from area residents.

Mew Gull In Alberta, Mew Gulls are known to breed only in the Lake Athabasca area. Our sighting of a single bird is not surprising given the regular occurrence of this species in the southern Yukon, Northwest Territories and northern British Columbia (Godfrey 1986).

Franklin's Gull Known in summer from the Hay and Zama Lakes areas but no nesting colonies found. Of the 7 birds taken from Bistcho Lake, 6 were adult males, 1 a sub-adult male. The lack of females and the relatively small gonad size of the males suggest that the birds did not form part of a breeding colony.

Caspian Tern In Alberta, Caspian Terns are known to breed only near the western edge of Lake Athabasca. Our sighting of a single bird is not atypical but represents a westward extension of the range of this species in Alberta.

Yellow-bellied Sapsucker The range in Alberta of the Yellow-bellied Sapsucker is not clearly defined because of the recent recognition of the Red-naped Sapsucker (*Sphyrapicus nuchalis*) as a separate species. Although *nuchalis* is considered a montane species it does occur east of the foothills (McGillivray, unpubl. data). All specimens from Bistcho Lake are pure *varius*.

Northern Flicker Three of the 4 specimens are pure Yellow-shafted forms but one has red tinges to the "moustache" indicating a hybrid Yellow shafted-Red shafted form. This supports the observation of

Table 1. Species collected or observed at Bistcho Lake but not recorded from the Caribou Mountains (Hohn and Burns 1975, 1976). Those marked with an asterisk were observed at Zama (Gunn *et al.* 1975).

Trumpeter Swan	Franklin's Gull
Canada Goose	Caspian Tern
Blue-winged Teal	Boreal Owl
Ring-necked Duck	Eastern Kingbird
Sharp-shinned Hawk	Solitary Vireo*
Red-tailed Hawk*	Cape May Warbler*
Broad-winged Hawk	Ovenbird*
Bald Eagle	Northern Waterthrush
Ruffed Grouse	Western Tanager*
Sharp-tailed Grouse	Fox Sparrow*
Sora*	Clay-colored Sparrow
Killdeer*	Red-winged Blackbird
Mew Gull	Common Grackle*
	Purple Finch

northward introgression of Red-shafted genes in Yellow-shafted populations in Alberta (McGillivray and Biermann 1987).

Boreal Chickadee Although Boreal Chickadees were common in the Bistcho Lake area no Black-capped Chickadees (*Parus atricapillus*) were observed. Given the distributions portrayed in Salt and Salt (1976) and Godfrey (1986), the absence of *atricapillus* is surprising. Gunn *et al.* (1975) and Höhn and Burns (1975, 1976) however, did not record *atricapillus* from Zama and the Caribou Mountains respectively. In the collection of the Provincial Museum of Alberta, the most northerly record of a Black-capped Chickadee in Alberta is from 12 km south of Ft. McMurray, considerably south of the Bistcho region. Yet Scotter *et al.* (1985) report *atricapillus* as common (although less so than *hudsonicus*) in Nahanni National Park in the southwestern part of the Northwest Territories. The conditions limiting the distribution of Black-capped Chickadees in the northern part of their range merit further study.

Solitary Vireo The Solitary Vireos from this region represent *Vireo solitarius solitarius* differing little from the form in eastern Canada. *Vireo solitarius cassinii*, although found in southern Alberta and eastern British Columbia, was not detected.

Warbling Vireo Despite the use of playback tapes, Warbling Vireos (*Vireo gilvus*) were not observed in the Bistcho area.

Blackburnian Warbler This warbler is common in eastern Canada but recorded only rarely in central Alberta. The single individual seen was in a Black Spruce tree in a mixed woods area north of the lodge. This sighting is considerably north and west of previous sightings in the province.

CONCLUSIONS

In the 9 days of field work in the Bistcho Lake area, 85 species of birds were collected or observed. No new breeding or occurrence records were found for Alberta but a number of northward range extensions were made. Of greatest interest is the lack of Black-capped Chickadees in the area suggesting unexplained gaps in the northern part of their range. As well, the presence of Trumpeter Swans suggests that a breeding colony may be in the area.

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MAMMALS OF THE BISTCHO LAKE AREA

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Prior to 1987, the mammalian fauna of the Bistcho Lake area had been the subject of only 1 study. In 1973 and 1974, Renewable Resources Consulting Services Ltd. conducted on-site and aerial surveys of the area (Jakimchuk 1974). Four species (Masked Shrew, Arctic Shrew, Southern Red-backed Vole, and Meadow Vole)[1] were recorded in September 1973 (Bodner and Wooley 1974). Aerial surveys for ungulates in November 1973 and February-March 1974 produced 2 species- Moose and Caribou (Pendergast *et al.* 1974).

An on-site survey of fur-bearers was made from 24 November to 8 December 1973. The survey consisted of identifying and counting the number of tracks encountered along transect lines. Seven species of fur-bearers were identified (Snowshoe Hare, Red Squirrel, Coyote, Red Fox, Marten, Ermine, and Lynx) (Wooley 1974a). Beaver colonies were surveyed by aircraft in October 1973. From the Northwest Territories border to Zama Lake, 143 colonies were counted with 38 in the area closest to Bistcho Lake (1974b). Using affidavits submitted by trappers, Boyd (1977) provided information on the fur-bearers of the much larger area covered by the Bistcho Lake Topographic Map Sheet 84M.

Before we left on the field trip to Bistcho Lake, a provisional list of the mammals of the area was prepared from the literature (Table 1). Thirty-six species were listed as potentially occurring in the area.

METHODS

A field camp was established at Tapawingo Lodge on a bay in the northeast end of Bistcho Lake (Fig. 1).

From 13-21 June 1987, we collected specimens by trapping and shooting. Sight records of mammals were also taken. Trapping consisted of setting a string of Museum Special traps in selected habitats for one or two nights. The traps were checked at least twice each day. Generally, 40 to 50 traps were set in each trap line. In total approximately 200 traps were used each trapping day. All specimens collected were frozen on-site for later preparation, or in the case of large mammals, they were skinned and fleshed out. All specimens have been deposited in the mammalogy collection of the Provincial Museum of Alberta.

The following definitions are used to provide an understanding of the "status" of the animal population:

Common: A species was expected to be in the area and it was observed on a regular basis with a number of individuals seen on each occasion. Alternately, it was captured during each trapping period.

Uncommon: A species was expected to be in the area but it was not seen regularly nor was it caught consistently.

Rare: The species was observed or caught only once. A person may not expect to encounter it.

Not determined: Although the species has been reported to occur in the area, it was not encountered during our survey.

ANNOTATED SPECIES LIST

Masked Shrew

Specimens collected: 16; Status: common.

The Masked Shrew was the only species of shrew that we caught. Bodner and Wooley (1974) captured 9 specimens and considered this species common. During our study, the Masked Shrew was found in a variety of habitats from dry, sandy areas to moist bogs. The largest collection was made in a spruce-aspen forest that had an understory of rose (*Rosa acicularis*) and grasses.

Arctic Shrew

Specimens collected: 0; Status: not determined

We did not capture any specimens of this shrew in the Bistcho Lake area. Bodner and Wooley (1974)

1. Scientific names for all species are listed in Appendix 1.

Table 1. Provisional checklist of the mammals of the Bistcho Lake area.[1]

Masked Shrew	Beaver	Black Bear
Dusky Shrew	Deer Mouse	Marten
Water Shrew	Southern Red-backed Vole	Fisher
Arctic Shrew	Heather Vole	Ermine
Pygmy Shrew	Meadow Vole	Least Weasal
Little Brown Bat	Muskrat	Mink
Northern Long-eared Bat	Northern Bog Lemming	Wolverine
Snowshoe Hare	Meadow Jumping Mouse	Striped Skunk
Least Chipmunk	Porcupine	River Otter
Woodchuck	Coyote	Canada Lynx
Red Squirrel	Gray Wolf	Moose
Northern Flying Squirrel	Red Fox	Caribou

1. Obtained from Soper (1964), van Zyll de Jong (1983, 1985).

reported that 1 specimen was taken during their study but made no comment on its status.

Bats

Specimens collected: 0; Status: not determined

Bats were observed flying around the lodge and over the lake. On the basis of size, one was identified as a Little Brown Bat and another was a Big Brown Bat. However, as it is extremely difficult to make positive identifications of bats in flight, these identifications are at best tentative and both these species are considered hypothetical.

Snowshoe Hare

Specimens collected: 0; Status: uncommon.

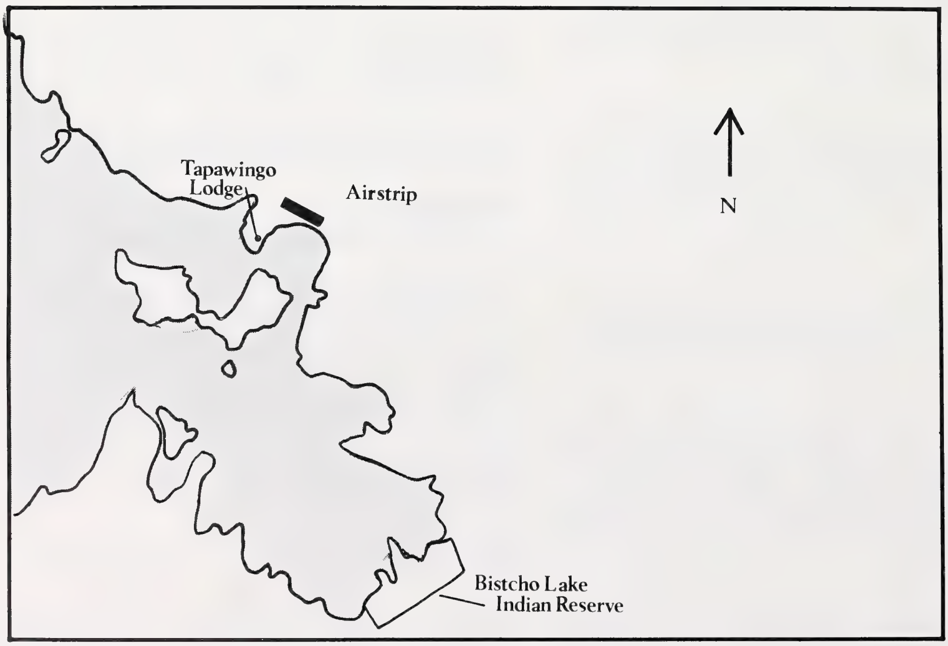

Figure 1. The study area on the east shore of Bistcho Lake.

One Snowshoe Hare was seen along a road in the vicinity of the fishing lodge. During a winter survey, Wooley (1974a) counted 65 tracks of this species in the Bistcho Lake area.

Least Chipmunk

Specimens collected: 6; Status: uncommon.

Chipmunks were observed and collected at the airstrip and within the area of the fishing lodge. They were not encountered at any other site. The area frequented by these chipmunks was along the edge of a disturbed Aspen Poplar (*Populus tremuloides*) forest. Bodner and Wooley (1974) did not encounter this species in the Bistcho Lake area.

Red Squirrel

Specimens collected: 10; Status: common.

The Red Squirrel was common in mixed wood (Aspen Poplar and spruce) habitats.

Beaver

Specimens collected: 7; Status: common.

The Beaver was very common in both Bistcho Lake and the streams entering the lake. Lodges were noted at several locations along the shoreline. Wooley (1974b) recorded a density of one beaver colony per mile during an aerial survey of the western side of Bistcho Lake. He considered this a fairly high density.

Deer Mouse

Specimens collected: 19 (males 12, females 7); Status: common.

The Deer Mouse was found in most habitats with the exception of moist bogs. It was collected in all upland, dry areas and on the one island that was surveyed. Bodner and Wooley (1974) did not capture any specimens of this species in the Bistcho Lake area. They speculated that the lack of Deer Mice was a result of poor cover and a lack of fallen logs.

Using size as an indicator of age, the female sample was made up of 1 juvenile and 6 adults. Five of the adults were pregnant with the number of embryos per female ranging from 5 to 7. One female was not pregnant but had eight placental scars. The male sample consisted of 2 juveniles and 10 adults. The 2 juveniles had abdominal testes that measured 2 mm by 4 mm, while the testes of the adult group were all scrotal and ranged in size from 8 mm by 15 mm to 7 mm by 11 mm.

Southern Red-backed Vole

Specimens collected 46 (males 32, females 14); Status: common.

This was the most common small mammal collected. It occured in a variety of habitats from bogs to dry, sandy areas. The largest number of specimens (15) was collected on a sandy, glacial outwash that was covered with Aspen Poplar and an understory of grasses. Bodner and Wooley (1974), who collected 189 specimens, found this to be the most common small mammal in the Bistcho Lake region.

Using size (weight, total length, state of pregnancy) as an indicator of age all females were adults. One was non-parous and showed no indication of having been pregnant, seven had embryos that ranged in number from 6 to 10, and 6 had placental scars. The male sample consisted of 28 adults, 3 subadults, and 1 juvenile. The testes in the adult group were all scrotal and ranged in size from 8 mm by 13 mm to 6 mm by 10 mm. The testes in the subadult group were scrotal and ranged in size from 7 mm by 10 mm to 9 mm by 16 mm. The juvenile had semiscrotal testes that measured 5 mm by 7 mm in size.

Meadow Vole

Specimens collected: 41 (male 23, females 18); Status: common.

This was the second most frequently encountered species in our study. It was not widely distributed however, being caught at only 3 sites. The largest number of specimens (34) was found in association with Red-backed Voles on a sandy, glacial outwash with a canopy of Aspen Poplar and an understory of grass. Bodner and Wooley (1974) captured only 4 specimens in their study.

The female sample consisted of 11 adults, 6 subadults, and 1 juvenile. All the adults were pregnant or had been pregnant. Ten had embryos (the number ranged from 4 to 9) and one showed placental scars. One of the subadult group was pregnant (4 embryos) and the remainder showed no sign of pregnancy. The juvenile was not pregnant. The male sample was made up of 7 adults, 5 subadults, and 10 juveniles. The testes in the adult group were all scrotal and ranged in size from 7 mm by 11 mm to 10 mm by 16 mm. The subadult group had testes that ranged in size from 6 mm by 8 mm to 9 mm by 12 mm. In four

the testes were scrotal and one was not determined. There was great diversity in the juvenile group with repect to the position of the testes. Five had testes that were scrotal, in two they were semiscrotal, and in three they were abdominal. The testes ranged in size from 2 mm by 4 mm to 8 mm by 11 mm.

Muskrat

Specimens collected: 8; Status: common.

The Muskrat was common in Bistcho Lake and in the streams and rivers flowing in and out of the eastern edge of the lake.

Meadow Jumping Mouse

Specimens collected: 5; Status: uncommon.

Jumping mice were collected at only 2 sites. Three specimens were collected on a sandy, glacial outwash that had a canopy of Aspen Poplar and a ground cover of grass. Two specimens were collected along the edge of the landing strip in grasses and rose. Bodner and Wooley (1974) did not record jumping mice in their Bistcho Lake study.

Porcupine

Specimens collected: 0; Status: not determined.

Wooley (1974a) observed Porcupine sign in the Bistcho Lake area. In 1987 we did not see any evidence of this animal.

Coyote

Specimens collected: 0; Status: not determined.

The tracks of 1 coyote were recorded by Wooley (1974a). He considered this species relatively rare. We did not see or hear any Coyotes in 1987.

Red Fox

Specimens collected: 0; Status: not determined.

Wooley (1974a) reported seeing 5 tracks of this species in the Bistcho Lake area and considered it relatively rare. We did not encounter any evidence of this animal.

Black Bear

Specimens collected: 2; Status: common.

Two black bears were collected close to the commercial fishing lodge. In addition, sign in the form of droppings was found in a number of areas.

Marten

Specimens collected: 0; Status: not determined.

Wooley (1974a) counted 16 Marten tracks in his study south of Bistcho Lake. He considered this species uncommon. We did not see any Marten sign during our survey.

Ermine

Specimens collected: 0; Status: not determined.

Wooley (1974a) found this species to be the most abundant terrestrial fur bearer in his study. He based this on the number of tracks counted. During our study no evidence of this species was seen.

Mink

Specimens collected: 1; Status: uncommon.

One Mink was collected in Bistcho Lake and one was sighted as it moved along the lakeshore. Wooley (1974a) reported the sighting of two tracks of Mink, but they were not on his survey transect and were not commented on further.

Wolverine

Specimens collected: 1; Status: rare.

A skull of a Wolverine was picked up along a cutline some distance from the field camp. Wooley (1974a) did not observe any sign of Wolverine during his survey.

Canada Lynx

Specimens collected: 0; Status: not determined.

Two lynx tracks were recorded by Wooley (1974a) for the Bistcho Lake area. He classified the lynx as relatively rare. We did not encounter this species in our survey.

Moose

Specimens collected: 0; Status: uncommon.

Two Moose, a cow and a calf, were seen on one occasion on an island in Bistcho Lake. This was the only cervid seen by the Museum field party.

Caribou

Specimens collected: 0; Status: not determined.

Wooley (1974a) and Pendergast et al. (1974) report seeing Caribou or evidence of Caribou in the Bistcho

Lake area. During our survey we did not encounter this animal.

RESULTS AND DISCUSSION

We collected 162 specimens of 12 species. The three most abundant species were Southern Red-backed Vole (46 specimens), Meadow Vole (41 specimens), and Deer Mouse (19 specimens).

By comparing the species we collected and those reported by Bodner and Wooley (1974), and Wooley (1974a, b) to the species on the provisional checklist some interesting absentees are evident. We were not too surprised, for example, that neither the Heather Vole (*Phenacomys intermedius*) nor the Northern Bog Lemming (*Synaptomys borealis*) have been reported from the Bistcho area. Unless the right circumstances occur, such as proper trap placement and high populations, these species can be easily missed in a relatively rapid survey such as was conducted by our party.

We were surprised, however, at the low species richness of shrews in the area. According to Soper (1964) and van Zyll de Jong (1983) five shrew species could be expected in this area. The Masked Shrew was the only shrew species that occurred in any numbers. There is no apparent explanation for the absence of shrews.

Another species that should occur in the area but was not detected was the Northern Flying Squirrel (*Glaucomys sabrinus*). Traps were placed in trees to catch this species but failed to do so.

Boyd (1977) reported several fur bearers for the area encompassed by the Bistcho Lake Map Sheet. These include Gray Wolf (*Canus lupus*), Fisher (*Martes pennanti*), and River Otter (*Lutra canadensis*). From affidavits submitted by trappers, Boyd indicated that 46 percent of the trappers reported Fisher, 17 percent reported wolf and 7 percent reported River Otter. There was no mention by Boyd where these trappers had their traplines, hence it is not possible to interpret these data with respect to the faunal compostion of Bistcho Lake.

Three terrestrial habitat types provided the greatest species richness. A disturbed area adjacent to the landing strip consisting of Aspen Poplar, rose, grasses, and deadfall had the greatest richness (5 species) although the number of specimens obtained was not high (12 specimens). The area that produced the largest number of specimens (55 specimens of 4 species) had a sandy substrate with a canopy dominated by Aspen Poplar with a few scattered pine trees and a ground cover of grasses. The third area yielded 4 species and 12 specimens consisted of a spruce-Aspen Poplar mix with rose and grasses as the understory. The lake, or aquatic habitat, produced 3 species and 16 specimens.

The mammalian fauna of the Bistcho Lake area is classified as a boreal forest mammal community. Of the 22 species of mammals reported here (Appendix 1), 64 percent (14) have affinities for northern or boreal areas. Thiry-six percent (8) have ranges so extensive that they can not be assigned to a single community.

ACKNOWLEDGMENTS

I would like to thank the following Museum personnel for assisting in the collecting of mammals in the Bistcho Lake area. William (Bill) Weimann and Michael Luchanski, technicians, both were responsible for the trapping program. Gary Erickson and Dr. P.H.R. Stepney were also responsible for collecting important specimens (chipmunks, beavers, muskrats, and bears). Dr. Stepney was also responsible for arranging the trip and logistical support. Without these people this project would not have had the success it achieved.

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APPENDIX 1. MAMMAL CHECKLIST FOR THE BISTCHO LAKE AREA.

Masked Shrew (*Sorex cinereus*)
Arctic Shrew (*Sorex arcticus*)
Snowshoe Hare (*Lepus americanus*)
Least Chipmunk (*Tamias minimus*)
Red Squirrel (*Tamiasciurus hudsonicus*)
Beaver (*Castor canadensis*)
Deer Mouse (*Peromyscus maniculatus*)
Southern Red-backed Vole (*Clethrionomys gapperi*)
Meadow Vole (*Microtus pennsylvanicus*)
Muskrat (*Ondatra zibethicus*)
Meadow Jumping Mouse (*Zapus hudsonius*)
Porcupine (*Erethizon dorsatum*)
Coyote (*Canis latrans*)
Red Fox (*Vulpes vulpes*)
Black Bear (*Ursus americanus*)
Marten (*Martes americana*)
Ermine (*Mustela erminea*)
Mink (*Mustela vison*)
Wolverine (*Gulo gulo*)
Canada Lynx (*Felis lynx*)
Moose (*Alces alces*)
Caribou (*Rangifer tarandus*)

Hypothetical
Little Brown Bat (*Myotis lucifugus*)
Big Brown Bat (*Eptesicus fuscus*)

NATURAL HISTORY OCCASIONAL PAPER TITLES

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